# Navigation Risk Assessment

# Marlborough Sounds Salmon Farms

Prepared for Ministry of Primary Industries
by
Navigatus Consulting

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# 1. Executive Summary

This risk assessment report, produced for the Ministry for Primary Industries (MPI), presents an overall assessment of the navigational risks associated with nine proposed salmon farms in the Tory Channel and the Waitata Reach area of the Pelorus Sound of the Marlborough Sounds. This work is intended to inform an application under the Resource Management Act. Potential interactions with both large ships and smaller craft operating in the area are considered, as well as the potential effects of a farm breakaway event.

The risk assessment process and terminology used in this investigation follows that given in AS/NZS ISO 31000:2009. The level of *navigational risk* is compared qualitatively to that for existing farms and other comparable navigational hazards.

This assessment has considered the following risk scenarios:

- The causes and effects of a large vessel passing close by or impacting a salmon farm.
- The risk associated with the potential to influence the actions of a master or skipper.
- The interactions between a small vessel and a salmon farm.
- The causes and effects of a farm breaking free and creating hazard to other vessels and water users.

No site prevents access to existing wharfs, navigation between the proposed farms and the shoreline or the use of bays for shelter. Whilst the farms would increase marine traffic, especially when constructing or relocating the farms, the effect can be considered minimal.

There is a conceivable possibility of a farm breaking free and thus creating a navigational hazard. However, experience has shown that this hazard can be adequately mitigated by good engineering design and other practical controls. The addition of a position monitoring system would reduce the risk to minimal by providing the farm crew good warning of undue movement of the farm.

Overall it has been found that the proposed farms would not unduly impede navigation and would have a very limited negative impact on navigational safety. The application of the controls identified in this report would further reduce any impact. It is noted that the farms should be correctly lit and will be crewed by well-equipped competent mariners with some knowledge of first aid and access to communications equipment. Given this and that the farms will be in known locations and their position charted, the presence of the farms could reasonably be considered to be an overall benefit to navigational safety.

# 2. Introduction

This risk assessment report, produced for the Ministry for Primary Industries (MPI), presents an overall assessment of the navigational risks associated with the nine proposed salmon farms in the Tory Channel and the Waitata Reach area of the Pelorus Sound of the Marlborough Sounds. This work is intended to inform an application under the Resource Management Act. Potential interactions with both large ships and smaller craft operating in the area are considered, as well as the potential effects of a farm break away. It is assumed that, if constructed, each new farm would coexist with the existing Te Pangu, Ngamahau and Clay Point salmon farms in the Tory Channel, the Waihinau Bay, Otanerau, Waitata, Kopāua (Richmond Bay) and Forsyth Bay salmon farm sites in the Pelorus Sound, and the numerous mussel farms currently located in the Pelorus Sound.

The report also considers the legislative requirements regarding navigational safety and how they affect the potential positioning of salmon farms.

The scope of this assessment is limited to the navigational risk associated with the salmon farms at the proposed locations. Other potential hazards and risks that may be associated with the farms and their operation are not considered unless there is the potential to influence the safety of maritime navigation. The term navigational hazard/risk[1] used throughout this assessment refers to the hazards/risks the farms present to vessels and the hazards to farm staff from vessels operating nearby.

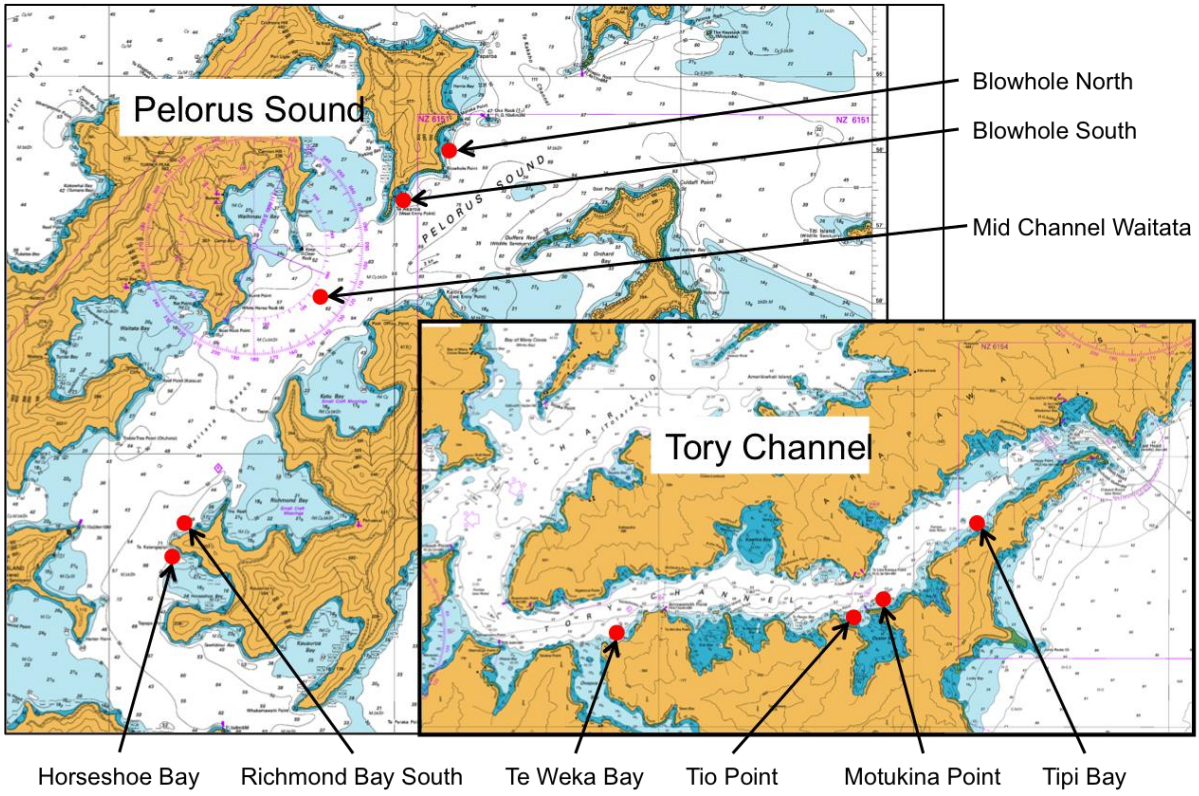
The farm sites considered are:

- Motukina Point, Tory Channel
- Te Weka Bay, Tory Channel
- Tio Point, Tory Channel
- Tipi Bay, Tory Channel
- Blowhole North, Pelorus Sound
- Blowhole South, Pelorus Sound
- Horseshoe Bay, Pelorus Sound
- Mid Channel Waitata, Pelorus Sound
- Richmond Bay South, Pelorus Sound

The locations are shown on Figure 1 below.

[1] AS/NZS ISO 31000 defines the term ‘hazard’ as ‘source of risk’.

**Figure 1 – Proposed Salmon Farm Locations**




It is noted that the proposed salmon farms do not share the bay they are located in with any existing salmon farm. The Mid Channel Waitata site is also remote from any existing salmon farm. The navigation risk for the farms is therefore considered independent of the existing farms – although the overall effect is considered.

## 2.1. The Risk Management Process

The risk assessment process and terminology used in this investigation follows that given in AS/NZS ISO 31000:2009 and consists of four steps: Establish Context, Risk Identification, Risk Analysis and Risk Evaluation. This assessment considers:

- Navigational risk created by the presence of salmon farms in the Marlborough Sounds; and
- Hazard potential from farm failure modes.

To ensure coverage of the four key risk assessment steps the following tasks were completed to the level indicated:

1. Understanding the context – Discussion provided in Section 3 and identification of stakeholders. Identified key stakeholders for navigational hazards are those operating ferries, other commercial vessels, farms, as well as recreational and pleasure craft.
2. Identification of risks – Through; discussions with stakeholders and experts with local professional experience, investigations of cage designs, professional maritime knowledge supported by site visits as well as prior research extending back to 2012.
3. Consultation with key stakeholders – Consultation with Interislander ferry operators including during a return trip on the ferry Aratere viewing the proposed farm locations from the vessel's bridge, discussions with masters and crew and a meetings with the Interislander marine operations managers. Strait Shipping provided telephone comments through their marine manager following consultation with masters. Additional information was obtained from a local water taxi operator and a fisheries compliance officer who monitors fishing activities in the Pelorus Sound and discussions with Tassel salmon famers based in Tasmania.
4. Analysis and Assessment of Risk – this report forms the analysis and assessment of risks (expressed in relative terms) based on information received from stakeholders, site visits, independent investigations and extensive maritime professional training and knowledge.

The key method used to assess risk during this assessment involves a qualitative risk study utilising comparisons between existing hazards and similar situations. A quantitative assessment would have been unsuitable for the following reasons:

- Lack of statistically credible representative maritime accident data involving incidents between vessels and salmon farms in general.
- A lack of statistically credible representative local maritime accident data involving salmon farms in the Sounds.
- The unique situation represented by the proposed mid channel salmon farm. Although similar overseas examples exist this is new for salmon farming in the Marlborough Sounds.
- Nature of low probability events with many site-specific variables.

The level of *navigational risk* is therefore compared qualitatively to that for existing farms and other comparable navigational hazards.

# 3. Context

## 3.1. Construction of Salmon Farms

For successful salmon aquaculture, a farm requires a good depth of water, strong water flow, well oxygenated and unpolluted water, a sheltered location, and steady temperature of 12°C - 17°C. The nine proposed locations were identified by MPI, in conjunction with salmon aquaculture experts, as potentially meeting these base considerations.

There are three designs proposed.

- A rectangular steel farm design similar to that in operation at Clay Point (Figure 3) and Te Pangu (Figure 4 and Figure 5). This design comprises a buoyant steel structure, with netting to contain the salmon and keep predators out.
- Rectangular design manufactured by an established overseas company; the Wavemaster. Key differences of this design over the earlier all steel design (Figure 2 and Figure 6) are; a lower overall profile, hinged structural assembly (on both the platforms and mooring mounts), and use of foam filled plastic structures for buoyancy.
- A circular farm design, made up of a plastic tube ring and netting (Figure 7). This design has only recently been implemented in the Beatrix Bay site in the Pelorus Sound and represents a change from established local practices, as a steel frame design is currently used for all other existing farms in the Marlborough Sounds.

All the designs have buoyant structures held in place by a mooring system connecting the entire farm to the seabed by means of tensioned cables or rubber flexi moorings and screw anchors. The designs can also have a barge containing living, office and servicing quarters for staff and an area for supplies. It is usual for the farm staff to live aboard the farms and so be available at all times. It is understood that a floating feed storage structure may also be employed if required to service a farm.

**Figure 2 - A Wavemaster type farm design as viewed in Forsyth Bay (since moved to the Waitata site)**

**Figure 3 – Rectangular design farm at Clay Point (viewed from a large vessel)**

**Figure 4 - Rectangular steel design farm at Te Pangu (viewed from a small vessel)**

**Figure 5 - Detail view of the farm at Te Pangu (steel rectangular design)**

**Figure 6 – A Wavemaster type design farm for the proposed farms (the buoys may not be required for use on sites in the Marlborough Sounds)**

**Figure 7 - Circular farm design proposed for three sites in the Pelorus Sound (Indicative new design also shown)**

## 3.2. Existing Salmon Farms in Region

Salmon farming is well established in the region with, at the time of writing, sea farm locations being as follows:

**Table 1 - -Established Salmon Farms**

| Name | Location | | Name | Location |
|---|---|---|---|---|
| Te Pangu | Tory Channel | | Forsyth Bay (currently fallow) | Forsyth Bay |
| Clay Point | Tory Channel | | Kopāua (Richmond Bay) | Waitata Reach |
| Ngamahau | Tory Channel | | Otanerau | Waitata Reach |
| Ruakaka | Queen Charlotte | | Waitata | Waitata Reach |
| | | | Waihinau Bay | Waitata Reach |

## 3.3. Proposed Locations of Salmon Farms

Salmon farms have been proposed for a total of 9 sites; 4 in Tory Channel and 5 in Pelorus Sound:

**Table 2 - Proposed Salmon Farms**

| Name | ID | Location | Design | Notes |
|---|---|---|---|---|
| Motukina Point | #82 | Tory Channel | Rectangular design | Within bay |
| Te Weka Bay | #47 | Tory Channel | Rectangular design | Within bay |
| Tio Point | #156 | Tory Channel | Rectangular design | Within bay |
| Tipi Bay | #42 | Tory Channel | Rectangular design | Within bight of coast |
| Blowhole North | #34 | Pelorus Sound | Circular design | Within bight of coast |
| Blowhole South | #122 | Pelorus Sound | Circular design | Within bay |
| Horseshoe Bay | #124 | Pelorus Sound | Rectangular design | Within bay |
| Mid Channel Waitata | #125 | Pelorus Sound | Circular design | In open water |
| Richmond Bay S | #106 | Pelorus Sound | Rectangular design | Within bay |

Charts and diagrams showing the locations in detail are in Appendix A.

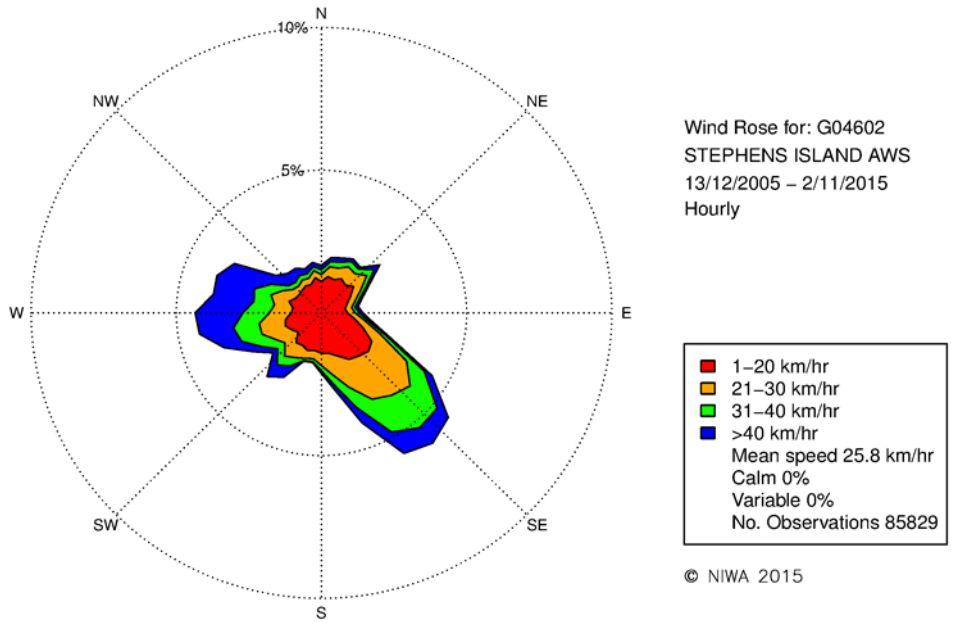
## 3.4. The Marlborough Sounds

Covering some 4,000 km$^2$ the Marlborough Sounds are an extensive network of sunken valleys inundated by the sea. The highly convoluted coastline covers 1/5 of the length of New Zealand's coast and is notable for its steep, part wooded hills, small quiet bays and sparse population. The Sounds provide shelter from the notorious Cook Strait currents and winds. However, the close in high hills and their associated deep valleys also channel the wind, making the Sounds a mixture of areas of sharply gusting winds and comparative calm. The Sounds are generally over 30m deep with the steeply sloping shoreline ensuring this depth is maintained close inshore.

### *3.4.1. Wind and Currents*

The wind rose for Stephens Island, located in the Cook Strait North of the Marlborough Sounds is at Figure 8. This is illustrative of the speed and direction of winds in the area. However, the reaches and headlands of the Sounds can have a major funnelling effect on the wind, significantly altering the direction and strength. This affects a vessel's ability to travel under sail. For vessels motoring, the wind in the Sounds would not be generally considered a significant hazard particularly if compared to the nearby Cook Strait. Nevertheless small craft do have to be aware of the wind, particularly when it opposes the tide and in the wider reaches of the sounds.

**Figure 8 - Wind Rose for Stephens Island**




The spring tidal range in the Marlborough Sounds varies between 2.6m at Havelock at the head of Pelorus Sound, 2.3m at the entrance to Pelorus Sound and 1.5m at Picton at the head of Queen Charlotte Sounds. Whilst the range is moderate the large volume of water in the sounds is channelled along the comparatively narrow reaches resulting in significant tidal currents.

### 3.4.2. Tory Channel

Tory Channel lies at the North East end of the Marlborough Sounds. It joins Queen Charlotte Sound to the Cook Strait and in doing so cuts Arapaoa Island[2] off from the South island. The channel is deep and narrow; 9nm long, but only 0.3nm wide at its narrowest point. There is a strong tidal current, which is most noticeable at its eastern entrance, reaching 5 knots on spring tides. The steep hills either side of the channel largely shield the channel from the wind although the valleys do funnel the wind leading to areas of severe gusts. The channel is part of the shortest route from Wellington to Picton and so is used by the ferries crossing Cook Strait. The Tory Channel Controlled Navigation Zone is at the eastern end of the channel, which places controls including harbourmaster permission to enter for vessels other than ferries over 500 gross tonnes, only having one ship of more than 350 gross tonnes in the zone at any time, and a mandatory radio call for all vessels entering the zone.

### 3.4.3. Recognised Navigational Route

Tory Channel is part of the National Transportation Route, a recognised navigational route. The larger ships, notably the ferries follow the normal rules of the road and so keep to starboard of the channel (northern side when making for Picton, southern side when making for Wellington). The International Maritime Organisation requires all ships of 300 gross tonnage and upwards, engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships to be fitted with an Automatic Identification System (AIS) that transmits and receives ships' positions. The AIS therefore allows the positions of ships to be tracked and recorded; the tracks of the ferries using the Tory Channel are shown in Appendix B. The two distinct tracks can be clearly seen. The Tory Channel Controlled Navigation Zone is also clear as the area where the two tracks combine.

### 3.4.4. Vessel Activity in Tory Channel

Tory Channel is used by a number of stakeholders:

- Ferries
- Marine farm servicing vessels and workboats
- Smaller commercial fishing boats
- Water taxis
- Essential travel by local residents
- Pleasure craft – motorised
- Pleasure craft – yachts
- Sightseeing boats
- Logging vessels

Vessel activity in Tory Channel is dominated by the ferry traffic from Wellington to Picton. The ferries are between 13,000 and 22,000 gross tonnage, carrying between 400 and 1400 passengers along with road vehicles and, for some, rail cars. The ferries are all twin shaft

[2] Charted as Arapawa Island.

vessels. There are typically 8000 ferry transits per year. The ferries are manned by professional crews subject to training and experience criteria, and are closely regulated by Maritime New Zealand. As can be seen from the AIS tracks in Appendix B, the ferries adhere rigorously to the recognised navigational route with slight deviations only to increase the distance between passing ferries or, occasionally, to avoid smaller craft. Of note, craft under 500 gross tonnage are required to avoid craft over 500 gross tonnage within the pilotage area.[3] In addition there is a prohibited zone extending 500 metres ahead and 50 metres to the side and stern of a vessel over 500 gross tonnage.[4]

Very few cargo ships transit Tory Channel, preferring the more open entrance to Queen Charlotte Sound, a seen by the AIS tracks at Appendix B. However, all vessels without a pilot exemption must take on a pilot before transiting the Sounds; the pilots having expert knowledge of the local area. The above points apply equally for smaller ocean going cruise vessels, while the masters of larger cruise vessels would not choose to transit the narrow and difficult entrance to Tory Channel.

The smaller commercial vessels plying Tory Channel can be assumed to be manned by professional crews. These are itinerant[5] but generally have a good knowledge of the area and in particular the vagaries of the currents and wind. These vessels are typically craft servicing the aquaculture farms, local fishing boats or local water taxis carrying up to 20 passengers. From time to time, somewhat larger vessels supporting logging operations may be in the area, but this is seldom and can be classed as occasional-itinerant.

The adverse wind conditions mean that yachts tend to transit along the Tory Channel under motor. Pleasure craft tend to avoid the ferry routes by travelling closer to shore, although nominally aiming to stay over 200m from the shore and so avoid the 5 knot speed limit[6]. These craft are generally trailer boats up to approximately 5m with one or more engines greater than 90hp, most likely equipped with chart plotters and typically carrying up to 5 passengers. There is a wide range in levels of local knowledge and seamanship skills across the recreational sector. This is in line with other regions around the country. In general the level of skill and knowledge of local conditions and rules including the recognition of maritime signs is apparently typically poor. Whilst most small craft do not carry AIS, the AIS tracks at Appendix B are informative in showing that small craft prefer to use the wider Queen Charlotte Sound than the Tory Channel.

It is important to note that the general level of boat activity in the Tory Channel is very low.

[3] Maritime New Zealand, 2011. Maritime Rules Part 91 - Navigational Safety Rules.
[4] Maritime New Zealand, 2011. Maritime Rules Part 91 - Navigational Safety Rules, Marlborough District Council, 2010. *Navigation Bylaw*.
[5] In this context 'itinerant vessels' are those not routinely following a set route.
[6] Maritime New Zealand, 2011. Maritime Rules Part 91 - Navigational Safety Rules.

## 3.5. Pelorus Sound

The Pelorus Sound is a geographically complex area created by a network of drowned valleys with a main channel that extends from the Cook Strait for about 55km to the town of Havelock. There are a large number of inlets, bays, reaches and other sounds off this main channel. The area in the outer sound where the proposed farms are located is known as the Waitata Reach. Pelorus Sound is a gazetted pilotage area for vessels 500 gross tonnage or greater.

A number of natural hazards are present in the Sounds. These include, but are not limited to, logs and trees washed down from the Pelorus and Kaituna Rivers, a comparatively shallow entrance to Pelorus Sound which discourages approaches of very large vessels, submerged rocks and a navigationally complex environment due to the nature of the sound with its many reaches and bays.

### *3.5.1. Vessel Activity in Pelorus Sound*

There are a number of marine and maritime stakeholders present in the Pelorus Sound area. These include:

- Aquaculture workboats and related activities
- Commercial fishing vessels
- Tour, cruise and water taxis who service the local residents and tourists
- Essential travel by local residents
- Recreational and pleasure vessels of local residents, tourists and those related to the local boating clubs or partaking in sailing, cruising, fishing, diving or other recreational pursuits.
- Logging vessels
- Cruise vessels

Vessel activity in Pelorus Sound as a whole, relative to other regions of New Zealand (hotspots including Auckland and Wellington), would be characterised as sparse with mainly itinerant vessel activity[7]. This activity is seasonal with the bulk occurring during the summer months, on public holidays, weekends and over the Christmas period when enjoying the water is part of New Zealand culture.

The more common commercial vessels tend to be well equipped but relatively small power vessels with professional skippers who have very good local knowledge and seamanship skills. The tour operators typically carry up to 40 persons; while the water taxis are limited to around 20 persons and the other operators typically 5.

While large cruise vessels regularly visit the Marlborough Sounds, berth at both Picton and Nelson, and can safely navigate much of the Sounds area, there is little reason for them to enter the Waitata Reach. Cruise ship activity in the vicinity of the farms in this area can therefore be taken as infrequent if not rare.

Recreational vessels represent a significant proportion of vessel volumes during the peak periods. These vessels are characterised as generally trailer boats up to approximately 5m with one or more engines greater than 90hp and invariably equipped with chart plotters. In

[7] In this context 'itinerant vessels' are those not following a regular route.

the area where the proposed farms are, these vessels make up the bulk of all vessels. Such operations include fishing, diving, transportation to lodgings, general touring or transiting through Waitata Reach on route to other areas at high speeds. A few of these vessels transit from Havelock, but the majority enter the sounds from Elaine Bay or other road heads and transit through Allen Strait in Forsyth Bay. Havelock is the main source of vessels for the inner sounds (generally considered south of Tawero Point). Recreational craft typically carry up to 5 people. There is a wide range in levels of local knowledge and seamanship skills in the recreational sector. This is in line with other regions around the country. In general the level of skill and knowledge of local conditions and rules including the recognition of maritime signs is apparently typically poor.

Sailing boats make up a small proportion of vessels in the Waitata Reach. However due to the typography, travel under sail is quite difficult so motoring is the norm.

### *3.5.2. Natural Vessel Routes*

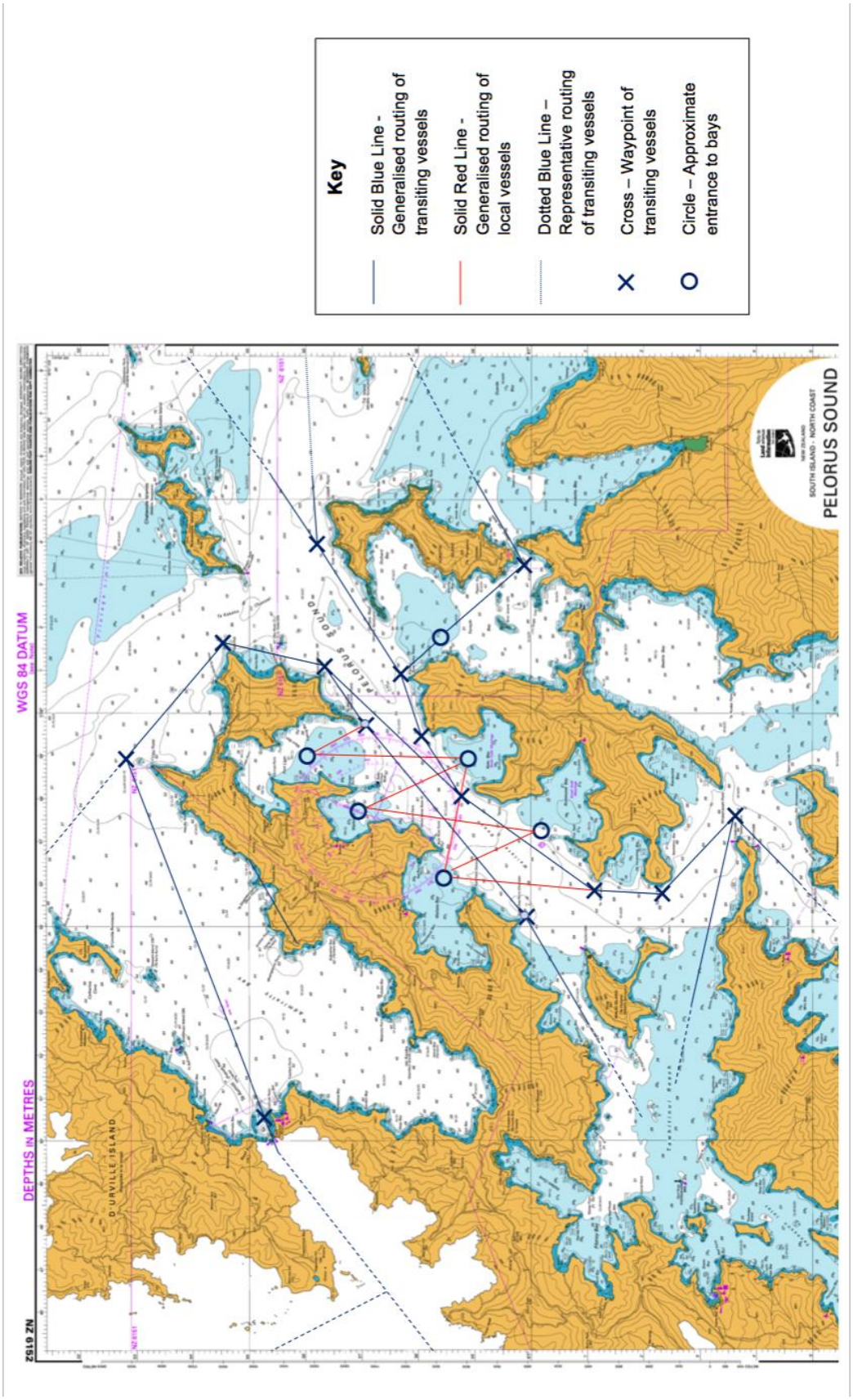
Pelorus Sound does not have formally recognised navigational routes with regular users on well-defined or programed paths, such as in Tory Channel with large ferries operating a formally defined path. Instead, itinerant recreational users and workboats servicing mussel farms on variable routes dominate activity in the area. Larger vessels will also be itinerant, with either logging vessels passaging to a particular bay for loading, or conceivably a larger cruise vessel potentially entering for a short sight seeing tour before heading back out.

Despite the lack of defined navigational routes and significantly less vessel activity than other areas of the Marlborough Sounds, there are commonalities in the way vessels transit through Pelorus Sound. Data from the Automatic Identification System (AIS) supplied by Maritime New Zealand (Appendix C) and discussions with local mariners helped to produce a natural transit route map to represent the natural routes taken by vessels in Pelorus Sound. This resulting map shown in Figure 9 and provides some guidance on the placement of all farms but especially the mid channel locations.

This map is based on the recognised mooring locations[8], recommended anchorages[9] transit routes from major locations outside Pelorus Sound and the view of local mariners following the principle of straight line point to point and normal chart or radar assisted navigation.

[8] Marlborough Sounds District Council (2016). *Moorings.* Retrieved from maos.marlborough.govt.nz.
[9] Murray, K. W. (2013). *New Zealand Cruising Guide - Central Area.*

**Figure 9 - Natural Vessel Routes - Pelorus Sounds**



## 3.6. Regulatory Requirements

The consideration of aquaculture farm placement falls under the Resource Management Act 1991. The Act aims to '*promote sustainable management of natural and physical resource'* and considers a very wide range of factors including economic, social and cultural. The Act considers 'effects' which includes 'a*ny potential effect of high probability and any potential effect of low probability that has a high potential impact.'*[10]

Maritime New Zealand has published Guidelines for Aquaculture Management Areas and Marine Farms. These are '*to support authorities while developing their aquaculture management areas, and to give guidance to marine-farm applicants on areas of concern for Maritime New Zealand in respect to navigational safety.*'[11] It is of note that the Aquaculture Management Area (AMAs) defined in the Resource Management Act[12] and the guidelines do not define the boundaries of a marine farm, but only define the areas where marine farming can take place.

In general the guidelines note that allowance should be made for the prevailing currents and sea states in each area. Consideration should be given to any increased traffic resulting from marine farms within the AMAs themselves. In addition to AMAs respecting existing anchorages, there needs to be consideration of places of refuges and a provision needs to be made to allow vessels to transit from recognised navigational routes to a suitable place of refuge. Overall the guidelines state that the farm should not unduly impede navigation.

The navigational guidance in the guidelines includes positional factors as follows:

- The AMAs should not unduly impede access to any bay, recommended or recognized anchorages or mooring areas, and shall not unduly impede navigation within the bay.
- AMAs should be kept clear of recognized navigational routes, navigational bottlenecks and port approaches.
- Offshore marine farms should not be located within 1000 meters, and inshore marine farms shall not be located within 500 meters of any recognised navigational route;
    - but, the separation distance will need to take into account such considerations as the size and type of vessels using the route, the layout of the area such as a bay, channel or open water, likely divergence from a set course, and prevailing currents and winds;
    - and, certain areas, such as within enclosed bays adjacent to a recognised navigational route, may be safe positions for AMAs, whilst an area some distance from a recognised route in open water may be considered a hazard.

[10] Resource Management Act, 1991. *Resource Management Act 1991*, Available at: http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html.
[11] Maritime New Zealand 2005, Guidelines for Aquaculture Management Areas and Marine Farms
[12] Specifically in the Resource Management Amendment Act (No2) 2004

- AMAs need to consider the access issues for pleasure and other small craft traffic between and around the AMAs. There should be clear access of at least 50 meters between the mean low water and the inshore boundary of any AMA, and a clear access way of 200 meters between any AMA and jetties and other points of regular use by watercraft.
- To ensure safe navigation around headlands AMAs shall not be located within 200 meters across any headland and 200 meters into bays adjacent to the headland.

# 4. Risk Identification and Analysis

## 4.1. Navigational Risk Scenarios

There are four main scenarios that could represent *navigational risk* for vessels from the presence of salmon farms in the Marlborough Sounds. These are:

- The causes and effects of a large vessel passing close by or impacting a salmon farm.
- The risk associated with the potential to influence the actions of a master or skipper.
- The interactions between a small vessel and a salmon farm.
- The causes and effects of a farm breaking free and creating hazard to other vessels and water users.

These scenarios may occur due in part to the behaviour of large vessels, smaller craft, the design and location of the farms, and the potential for engineering failure.

## 4.2. Large Vessel Collision with Farm

The vast majority of large vessels (i.e. over 10,000 gross tonnage) using the Marlborough Sounds are the ferries plying Cook Strait. Larger cargo ships do visit Picton, however it is rare for them to use Tory Channel as the preference is to transit via Queen Charlotte Sound. Even more occasionally a cargo or cruise ship will enter Pelorus Sound. It is evident from considering the 'persons-at-risk', given this type of event; the key risk is a collision between a ferry and a salmon farm in Tory Channel. As the passing frequency of a large vessel and a salmon farm in the Waitata Reach is very low, the transit speeds also low, and there being no reason for such a vessel to pass near to a farm in that area, this analysis focuses on the ferry / farm in the Tory Channel collision scenario.

In the event of a relatively fast moving ferry losing directional control and failing to remain in the main channel the main navigational hazard to the vessel is caused by the farm's steel structures. The nets themselves do not represent a direct hazard unless the structure itself has already been severely compromised. The mooring lines only represent a direct hazard if a vessel is within a few metres of the pen itself.

Cook Strait ferries draw between 5 and 6 metres. The mooring lines on the seaward side of the farms, typically in water deeper than 25m, angle down to the sea bed at approximately 5 to 1, that is 1m down for 5m across. The lines would therefore only present a hazard if the ferry is within 30m of the farm structure. The main hazard of a mooring line strike would be if the lines wrapped around the propeller or rudder of the ferry. This could disable the ferry's ability to manoeuvre. However, it is also likely to hold the ferry in place preventing further damage due to drifting onto the shoreline or even the farm itself. Alternatively the ferry would glance off the lines resulting in minimal damage to the ferry or its ability to manoeuvre. A mooring line strike could result in one or more mooring lines breaking, which could lead to a breakaway event. The shock could also lead to a motion on the farm, which could cause some of the occupants to lose their footing and suffer injury.

Given a collision event between a large vessel and a salmon farm, the farm pontoon structure would either ride up over the bow causing the farm to wrap itself around the bow of

the vessel or will sink underneath the vessel possibly fouling the propeller. The second scenario is less likely given the waterline length of ferries and the sealed, sectioned nature of the pen buoyancy pontoons, which would almost certainly remain afloat even if damaged. In a collision event, it can be expected that the netting would keep the farm in one piece. Therefore the chance of the farm breaking apart is very low. Both scenarios would lead to very few if any casualties on, and limited damage to, the ferry. The farm occupants could suffer injuries in the impact. The farm could also suffer structural failure, although this is likely to be localised and, as noted earlier, the farm is unlikely to sink

When considering a collision with a large vessel it is of note that in general large vessels operating in Tory Channel are properly manned with either a local pilot or master with a local exemption in charge of the vessel. The typical farm is large, well lit and visible on radar making them conspicuous to other vessels in all but the most difficult visibility conditions. This coupled with their location being charted, means they pose a limited hazard to navigators while the farms are properly located.

Given the introduction of the new Wavemaster design, which uses less rigid materials, in the event of a collision the result may differ from the expected behaviour of the more rigid design previously used in the Sounds. However the outcome of a collision can be expected to be similar to that of the existing farms.

Cargo and cruise ships do very occasionally enter Pelorus Sound and could pass by the proposed Mid Channel Waitata site. All of the Pelorus Sound is within the pilotage limit whereby ships must have a pilot aboard unless like the ferries they have an exemption; masters of ships visiting any less than very regularly would not have an exemption. It can therefore be safely taken that on the rare occasions that a ship passes the proposed Mid Channel Waitata site it would be under the control of a pilot very familiar with the local area. As noted above salmon farms in Pelorus Sound will be well lit and visible on radar. The likelihood of a collision between a large vessel and a salmon farm in Pelorus Sound must therefore be considered extremely remote.

### *4.2.1. Position of Farms*

The position of a farm is a critical factor to the level of risk they represent to vessels. Maritime New Zealand guidelines set out a series of factors to be taken into account in deciding where to locate salmon farms. A key requirement is that the proposed farms maintain a minimum distance off a recognised navigation routes so that they do not interfere with navigation. The extent to which this is important will vary according to the amount of maritime traffic, the type of traffic, the distance between the traffic and the farm and other variables such as wind, sea state/condition and visibility which are all factors in safe navigation. Accordingly there are many factors that influence where marine farms can be safely stationed. The guidelines state that if a farm is positioned within an enclosed bay it may be in a safe position. This is the case with the existing farms in Tory Channel.

#### *4.2.1.1. Distance and Position from Ferry Paths*

All the proposed sites are located on the southern side of Tory Channel. This positions them closer to the outgoing Picton to Wellington ferry route. This position is on the same side as the existing farm at Te Pangu. The Te Pangu and Clay Point farms are located landward of a transit line between the nearby headlands or in the case of the Ngamahau farm, within the bight of the nearby coast. When compared to the Te Pangu and Clay Point farms the proposed sites are positioned in less enclosed bays and as such, are somewhat more akin to the Ngamahau case. The sites at Te Weka Bay and Motukina Point have the farm structure to the landward side of the transit line between headlands; only the moorings and anchors are to the seaward side. The proposed site at Tipi Bay does have approximately half the farm structure seaward of the transit line between the nearest headlands.

The distance of each farm to the vessel paths is also a consideration for navigational safety. Approximate distances between the defined ferry route and the variability in actual ferry routes from AIS data for the month of March 2015 (see Appendix B) are shown in the table below. From the table it can be seen that three of the proposed sites lie at a greater distance from the defined ferry routes than the established farm at Clay Point and closer than the Te Pangu farm; only the site at Tio Point lies closer.

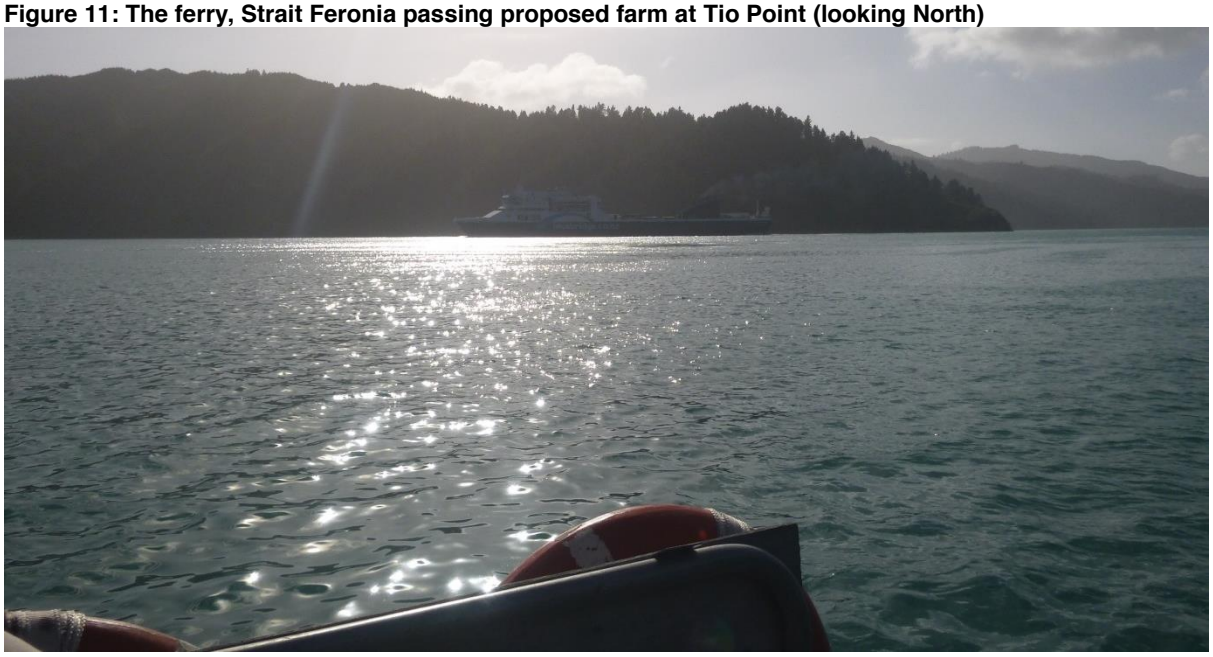
**Table 3: Proximity of ferry track**

| Site | Distance from Defined Route | Variation in Ferry Position from AIS Data |
|---|---|---|
| Te Pangu | 630m | -110m/+50m |
| Clay Point | 340m | -90m/+40m |
| Ngamahau | 324m | -90m/+40m |
| Proposed site #47 – Te Weka Bay | 380m | -10m/+170m |
| Proposed site #156 – Tio Point | 285m | -90m/+110m |
| Proposed site #42 – Tipi Bay | 410m | -90m/+110m |
| Proposed site #82- Motukina Point | 410m | -90m/+110m |

The transit of ferries in both directions was viewed in person at the proposed Te Weka Bay and Motukina Point farms, and the inbound ferry from the proposed Tio Point site (Figure 10). When viewed from the headland-to-headland transit line at the locations of the proposed farms the distance between the transiting ferries and the farms was observed as being similar between observation sites. No significant difference in proximity to the transiting ferries tracks was observed between the existing farms and the proposed farms.

**Figure 10: Aratere ferry passing proposed farm at Te Weka Bay (looking North West)**

**Figure 11: The ferry, Strait Feronia passing proposed farm at Tio Point (looking North)**



As noted before, the current Te Pangu and Clay Point farms lie landward of a transit line between the nearby headlands. As these sites have previously been deemed suitable, it is credible to suggest that, with all other things being equal, a farm positioned landward of the transit line between nearby headlands would produce a similar level of navigational hazard as that of the current farms given the greater hazard presented by the rocky headlands themselves.

When considering simply the distance to the normal ferry paths, the proposed farms at Te Weka Bay and Motukina Point can be judged to present a similar level of navigational safety risk compared to the existing farms.

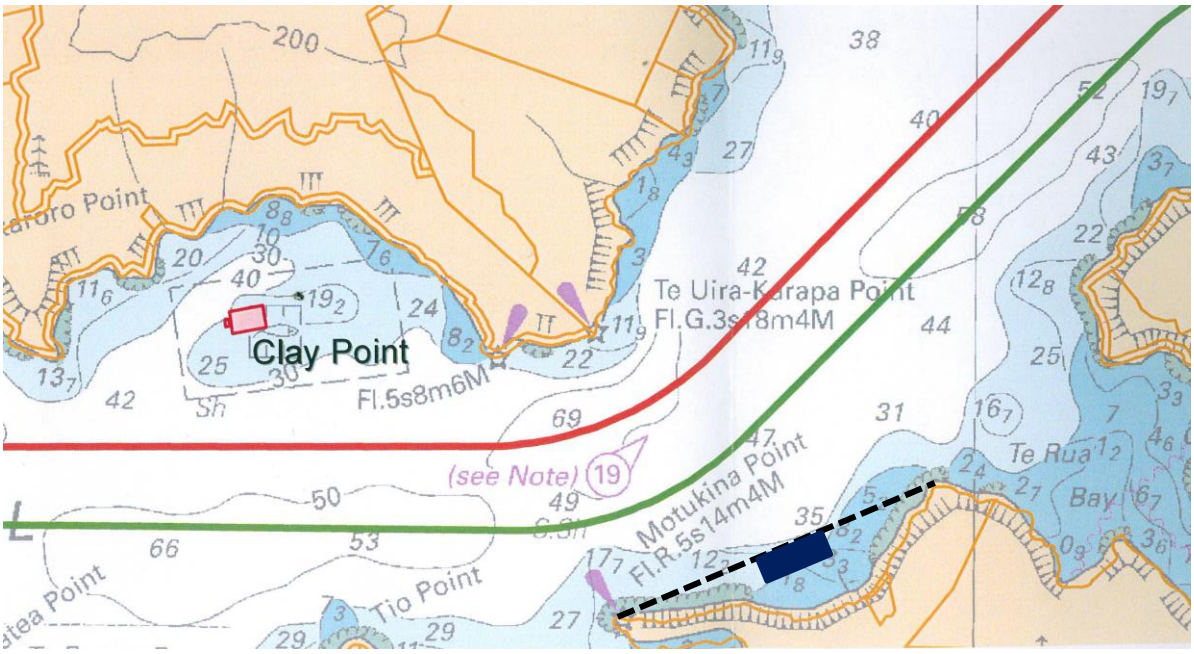
The farm at Tio Point is closer to the nominal ferry paths than the existing farms, which in itself could be considered to raise the navigational risk somewhat. However, the farm is inside the headland-to-headland transit line and as any ferry masters' actions would be to avoid the greater hazard presented by the rock headlands, this largely mitigates this risk. The closer proximity of the farm to the ferry path does increase the risk of interaction between the ferry and work boats operating on the seaward side of the farm. It is noted that the work boat crews are used to operating in the vicinity of ferries and, given the lack of incidents, the existing procedures are robust. However, it would be prudent to explore strengthening procedures designed to ensure as suitable separation between work boats and ferries. Overall the Tio Point site could be considered to only very marginally increase any risk to ferries.

Tipi Bay, is positioned slightly further seaward of the headland-to-headland transit line, so could nominally be considered to be more exposed to collision. However, this transit line is a somewhat arbitrary benchmark as any large vessel potentially interfering with the farm, would be within the bight of the nearby coastline and patently, already be in a 'loss of navigational control' situation. For these reasons the collision risk for a farm at Tipi Bay can be considered low and not be dissimilar to that for the existing Ngamahau farm site.

#### *4.2.1.2. Ferry path hazard*

Given the ferries have twin shaft and use established steering gear designs there is only a low probability that loss of direction control will occur while a ferry is transiting (Figure 12) on a steady bearing and so create an immediate hazard situation to a farm. However for a portion of their travel the ferries transiting outbound to Wellington will be steaming almost directly towards Motukina Point before making a programmed port turn. To assess this risk at the Motukina Point site in comparison to the existing sites a transit of the vessel Kaitaki was observed from the proposed site (Figure 13 and Figure 14).

**Figure 12: Ferry Paths (red: inbound, green: outbound) at the proposed site of Motukina Point (farm approximate location and size shown)**




The position of this farm could in theory create an increased collision risk in the event a ferry fails to make the turn as required. Such events could arise from a mechanical steerage problem, navigation error or interaction with other vessels. However, given that the farm is relatively close to shore, if a malfunction or error occurs, the presence of the farm would not in itself materially heighten the navigational risk to the vessel. Any large vessels in such a situation and location would be in immediate danger due to the near-by rocks and more than likely impact the shore as opposed to the farm structure. Given the inherently low probability of steering malfunction and the inherent hazard of the headlands and shore, it is considered that there is only a very limited chance of a collision with the farm. The limited damage from such a collision means the increased risk to the ferry, passengers, farm or occupants is not material.

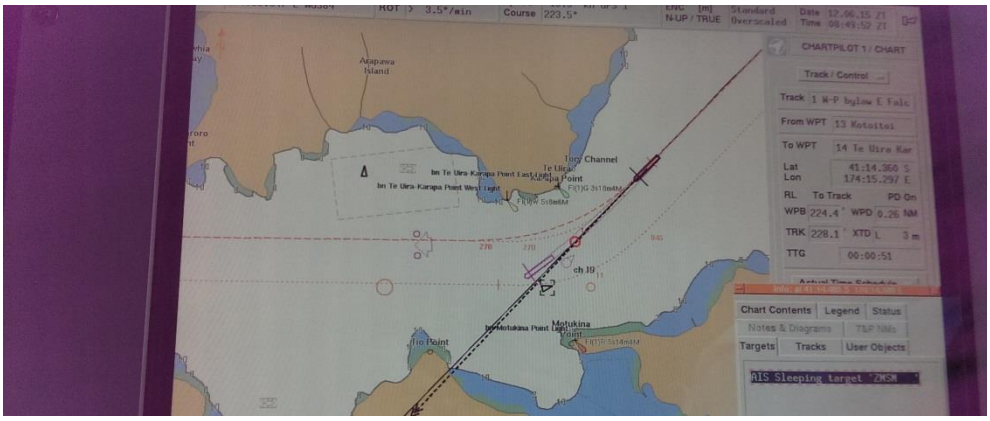
**Figure 13: Vessel Kaitaki on programmed path bow on to the proposed site of Motukina Point**

**Figure 14: Vessel Kaitaki negotiating a programmed port turn near the proposed site of Motukina Point**

Tory Channel narrows between Motukina Point and Te Uira Karapa point, creating what can be described as a 'pinch point'. It was reported that this can be a location where oncoming traffic is encountered[13]. Such a situation was observed when the Strait Shipping ferry Straitsman and the Aratere passed at this point (Figure 15). In this case, as it is understood is normal, both vessels made adjustments to ensure greater separation than the programmed course would otherwise create.

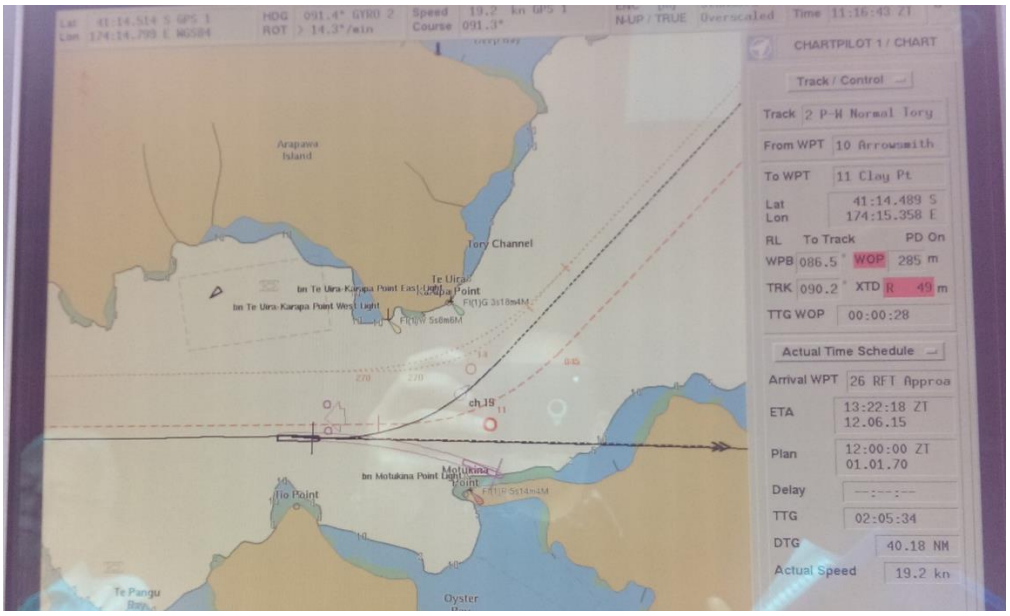
[13] email. (n.d.). MPI and Master Interislander Ferries.

**Figure 15: Vessel Aratere (black rectangle) and Straitsman (small triangle) passing at Te Ura Karapa Point (as viewed on the live navigation chart display on Aratera).**




On the return leg, the ability to purposely steer off-path, for passing another ferry, was demonstrated with the vessel set to approximately 50m starboard of the programmed path (as displayed on the electronic chart). At Tio Point and just prior to the programmed turn to port, some starboard wheel was applied and so during the turn to port cross track error increased a further 25m (Figure 16). This resulted in the vessel being 75m starboard of the programmed path line displayed on the electronic chart.

**Figure 16: Position of vessel Aratere (Picton to Wellington route) relative to defined path (red) in the position it would be if meeting another vessel on the turn i.e. 50m before turn and 75m during turn.**

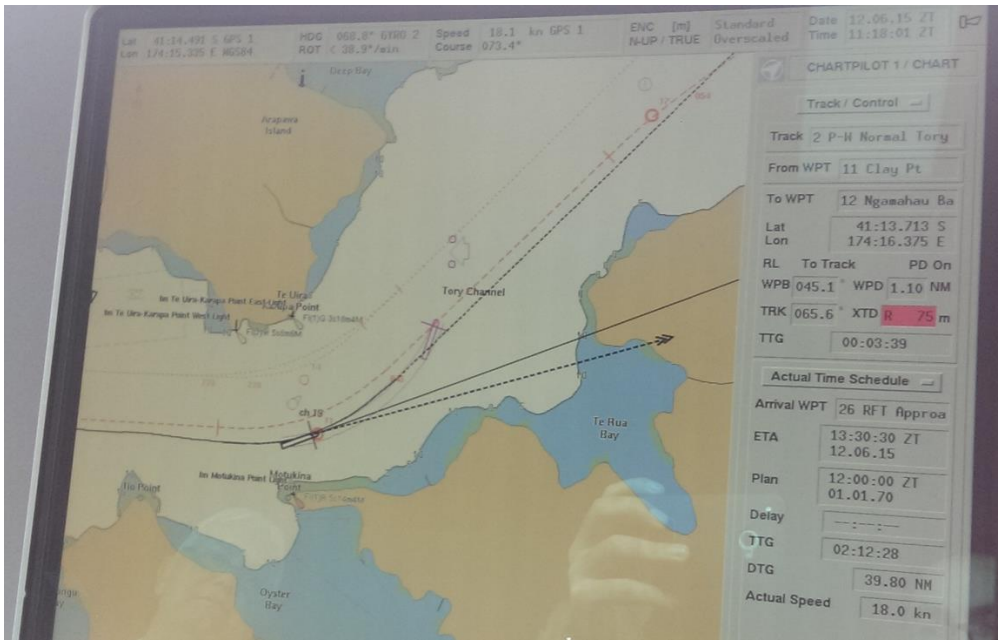



If extra sea room is given to an inward bound ferry, as observed with the Straitsman and later experienced on the Aratere, the distance between the proposed farm site at Motukina Point and the ferry will be less than normally programmed. Although this situation can occur at any site, at the Motukina Point site the turn creates an additionally complexity and due to the swing of the stern a further reduction in the normal clearance to the farm.

It was determined that the vessel path taken, along with the normal swing of the stern at the turn does not create a particular hazard under normal conditions. As the turn is initiated well before the farm location (Figure 17), the crew would be expected to have time to reduce

stern swing on the vessel. However, it is noted that this view is not aligned with that expressed by the marine managers of each ferry company interviewed.

**Figure 17: Starboard wheel prior to initiation of outbound turn to port for the vessel Aratere (Picton to Wellington route) relative to defined path (red).**




### *4.2.1.3. Concern Raised by Ferry Operators*

During consultation with ferry operators there was concern over the Motukina Point location. Although the comments were not stridently put, it was evident from discussion that the ferry operators would prefer for there not to be a farm located at the Motukina Point site. It should therefore be expected that a proposal for an actual farm at the site would be met with firm resistance from the ferry operators on a basis of navigational safety. Although Navigatus consider the site to be only marginally more hazardous than the existing features of Tory Channel from a navigational safety perspective, we can understand the perceived risk. When meeting another vessel or confronted with an unexpected situation when approaching the programmed turn at Motukina Point having a farm there would be one other factor to consider when responding. This additional factor may increase workload and so could be considered a contributory risk factor. This possibly may result in the ferry taking a path closer to the other vessel on the turn than they otherwise would have.

Although outside the scope of this work to propose mitigations it is noted that a few simple but probably effective mitigations could be considered to reduce the risk at the Tio Point and Motukina Point location. These include:

- Implement procedures to ensure that ferries do not pass on the turn at Te Uira-Karapa Point/Motukina Point location.
- Ensure salmon farm operators limit vessel/workboat movements at pinch points when ferries are within the proximity.

The above reasonable practicable controls have been assumed in the risk evaluation in Section 0.

## 4.3. Small Vessel Collision with Farm

There are many variables that would affect the consequences of collisions between small vessels and salmon farms. Such variables include; vessel size, speed, angle of impact, vessel shape, farm design, weather conditions, and position of persons on board vessel. However, generally the faster a vessel collides with a farm and the smaller the vessel size the higher the probability of a loss of life resulting from an incident. The relative greater size and heavier construction of the farm means that the damage to a small vessel and its occupants would more likely be greater than to the farm and its occupants.

Small vessels are much more manoeuvrable, are able to turn with a far tighter radius and stop significantly more quickly than larger vessels. This is particularly true of the smaller high speed vessels typically used for recreation and to a lesser extent water taxis. This increased manoeuvrability provides a significant mitigation to a collision arising from a combination of high speed and poor lookout by allowing a successful emergency manoeuvre at late notice.

### *4.3.1. Positions of Farms*

The specific position of a farm is a critical factor to the level of risk it may represent to vessel activity in the area. This section provides a summary of:

- The characteristics of each farm's position considering the possible uses of the surrounding area,
- Any notable features about the site,
- The relative marine activity likely to be experienced around the farm,
- A measure to reflect the position of the farm relative to the nearest headlands.

#### *4.3.1.1. Measures Used*

The vessel AIS tracks reinforced the local advice that most small craft travel from headland to headland, well to the side of a channel. In Tory Channel this is reinforced by the need to avoid the ferries that tend to the centre of the channel. Around Pelorus Sound this comes from the desire for the shortest route to the destination, along with the fact that the flattest water that offers the most comfortable ride is found inshore where the land shields the water from the wind, and that navigation is easier headland to headland.

When rounding a headland at speed a collision may occur if the boat comes unexpectedly upon a salmon farm and does not take evasive action in time. A measure for when a farm is observed from a travelling vessel has been calculated. The calculation is based on the assumption that in extreme situations vessels with skippers behaving unsafely may pass within 50m of a nearby headland, well within the 200m maritime rule[14], at a speed of 20 knots. The measure is taken between the 50m mark from the nearest headland and the cage boundary.

There are no guidelines or accepted standards on what is a reasonable reaction time for small craft drivers. However, it is noted that the Maritime NZ Guidelines state that the farm should be at least 200m from a headland. Allowing for a craft travelling at 20 knots 50m off the shore this would mean a reaction time of some 25 seconds.

[14] Maritime rules specify a maximum speed of 5 knots within 200m of a headland.

A second measure rates the marine activity in the surrounding area on a relative scale. This scale accounts for the number of vessels typically operating in the area, the size of vessels, the frequency of operation and the manoeuvring room available. The relative scale used is shown in the following table and focuses on the Marlborough Sounds Area.

**Table 4 - Relative Marine Activity Rating**

| Rating | Description |
|---|---|
| Very High | Picton Harbour. 40+ Movements per day |
| High | Tory Channel approx. 10 Movements per day |
| Medium | Multiple Daily Activity |
| Low | Daily Activity |
| Very Low | Weekly Activity |

**Table 5 - Proposed Sites – Summary Table**

| | |
|---|---|
| **Motukina Point** | |
| Headland Reaction Time | Headland (north of farm) = 39 seconds<br>Motukina Point (south of farm) = 46 seconds |
| Use of Bay | Wharf |
| Notable nearby features | Nil |
| Activity Rating | High |
| **Tio Point** | |
| Headland Reaction Time | Tio Point (west of farm) = 37 seconds<br>Motukina Point (east of farm) = 44 seconds |
| Use of Bay | Wharf |
| Notable nearby features | Nil |
| Activity Rating | High |
| **Te Weka Bay** | |
| Headland Reaction Time | Tepapaweka Point (north of farm) = 62 seconds<br>Headland (south of farm) = 43 seconds |
| Use of Bay | Wharf |
| Notable nearby features | Nil |
| Activity Rating | High |

| | |
|---|---|
| **Tipi Bay** | |
| Headland Reaction Time | Headland (north of farm) = 62 seconds<br>Headland (south of farm) = 79 seconds |
| Use of Bay | None |
| Notable nearby features | Nil |
| Activity Rating | High |
| **Blowhole North** | |
| Headland Reaction Time | Mataka Point (north of farm) = 55 seconds<br>Blowhole Point (south of farm) = 55 seconds |
| Use of Bay | Refuge |
| Notable nearby features | Multiple Mussel Farming |
| Activity Rating | Low |
| **Blowhole South** | |
| Headland Reaction Time | Blowhole Point (north-east of farm) = 42 seconds<br>Te Akaroa Point (south-west of farm) = 2 minute |
| Use of Bay | Refuge |
| Notable nearby features | Proposed mooring, within headland to headland line. |
| Activity Rating | Low |
| **Horseshoe Bay** | |
| Headland Reaction Time | Te Kaiangapipi (North of farm) = 36 seconds |
| Use of Bay | Shelter |
| Notable nearby features | Mussel farms, Moorings, within headland to headland line. |
| Activity Rating | Within bay: Low<br>Proximity of bay: Medium |
| **Mid Channel Waitata** | |
| Headland Reaction Time | No nearby headlands (natural visibility) |
| Use of Bay | N/A |
| Notable nearby features | Mid Channel |
| Activity Rating | High |

| **Richmond Bay South** | |
|---|---|
| Headland Reaction Time | The Reef (North-East of farm) = 1 minute 23 seconds Te Kaiangapipi (South-West of farm) = 55 seconds |
| Use of Bay | None |
| Notable nearby features | Mussel farm and prominent reef, within headland to headland line |
| Activity Rating | Within bay: Low<br>Proximity of bay: Medium |

#### *4.3.1.2. Mid Channel Farm*

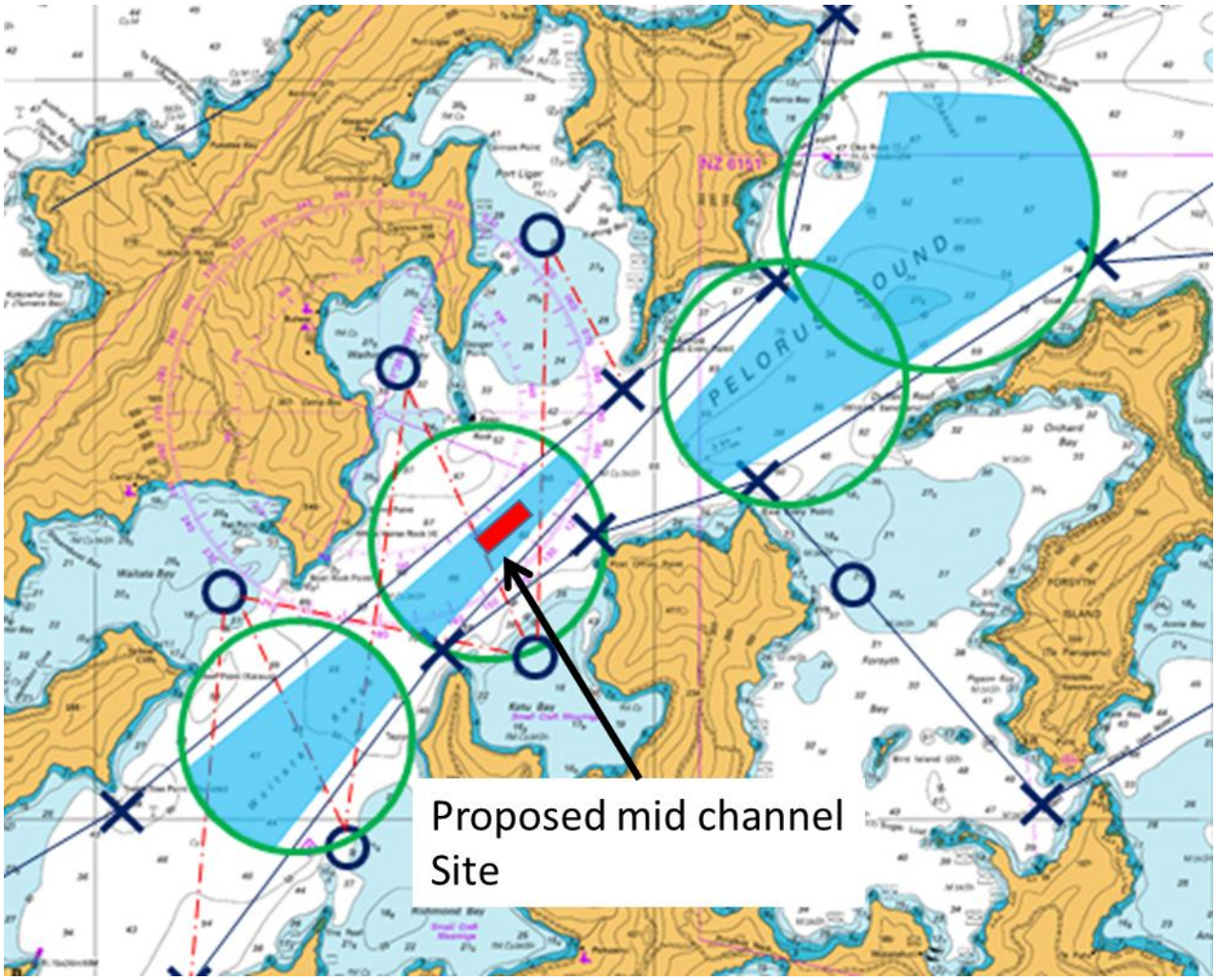
The proposed location of the mid-channel farm in Pelorus Sound allows some scope of location to both manage navigational risk as well as address any additional constraint from a salmon rearing, ecological or conservation perspective.

To determine the suitable positions from a navigational risk perspective the chart shown in Figure 18 was developed. This shows the regions navigationally most suitable for the mid channel farms are shown as light blue areas. These areas were determined based on the following criteria:

- Avoidance of generalized routes for transiting vessels (represented by the solid blue line). The generalised routes for local vessels (represented by the dashed red line) is less of a constraint for mid channel farms due to greater flexibility for skippers.
- Greatest flexibility for vessels to pass the farm. The circles show the area of the naturally greater expanse of water. These are generally formed in the entrance to each bay. Placing farms in these gives the greatest flexibility on each side of the farm for the skippers to choose to pass. Naturally the most space for passing vessels is created when the farm is located in the center of a circle.

The site of the proposed mid-channel farm is marked as a red rectangle on the figure.

**Figure 18 - Suitable Mid-Channel Sites (Refer to Figure 9 for key)**




### *4.3.2. Impact of Farm Positions on Natural Vessel Routes*

With the exception of Blowhole North none of the farms are located in natural navigational routes. In the case of Blowhole North skippers passaging to or from the North or West of the bay would need to give it a wider berth than is currently the case. It could therefore be argued that Blowhole North has an impact on routine vessel navigation and so presents some risk. With the exception of the mid channel farm, all other farms are located within bays and so are outside of natural or possible passages.

## 4.4. Other Navigational Risk Considerations

### 4.4.1. Access to Bays, Wharfs and Mussel Farms

It can be seen that, when compared to the numerous existing mussel farms in the area, the proposed sites do not restrict access to the bays or other points of navigational interest. Motukina Point and Te Weka Bay are located in bays with wharfs. However, the Te Weka Bay farm is sited 200m clear of the wharf and so allows a wide access channel between the proposed farm and the coastline. The Motukina Point farm is 150m from the wharf, and allows a similar distance for access. Whilst this is less than the Maritime NZ guidance it is noted that the wharf services only one house so the wharf is only in limited use. The guidance refers to 'points of regular use by watercraft'.

Access to mussel farms will be somewhat impeded at Horseshoe Bay and Blowhole North. However the mussel work boats that require access to the farms routinely operate between the mussel farm lines. The existence of salmon farms in close proximity will not pose a constraint or an additional hazard as the masters of these vessels are well able to navigate around the much more navigationally difficult mussel farms with their low visibility and low height above water.

### 4.4.2. Access to Shelter and Refuges

The farms at Blowhole Point North and Blowhole Point South are located in bays that could be considered refuges for small craft and yachts in a strong West to North West winds as the high ground would provide some shelter. The site of the farm at Horseshoe Bay could also offer some shelter from a strong North Easterly wind. To take advantage of the shelter the boats would have to anchor close to shore in water of less than 20m of water depth. It can be seen from the plans of all the farms that the farms are located in depths of water greater than 20m. The sites at Blowhole Point North and Blowhole Point South are both located at least 150m off shore, allowing sufficient room for boats to seek refuge between the farm and the shore. The site at Horseshoe Bay is somewhat closer to shore, as the sea bed drops away more steeply. However, it is evident from the navigational chart that better shelter could be found further into the bay; that the Cruising Guide[15] mentions that Horseshoe Bay offers calm seas at its Eastern extent in East to South winds, but that it is very gusty. It is therefore reasonable to consider that the farms would not hinder access to shelter or refuges.

### 4.4.3. During Construction and Installation of Farms

During the surveying, laying of farm anchors and installation of the farms themselves, there will be associated vessel activity that will differ and exceed that of the normal operation of farms. This may include farms under tow at night or during the day, an operation which mariners will need to recognise to avoid collision with often hard to see tow lines. There is no reason to think that the navigational safety impact of this short term and non-standard activity could not be effectively managed through normal project management and maritime safety procedures, practices and education – the maritime part of which would in turn need the Harbour Master's prior acceptance.

[15] New Zealand Cruising Guide Central Area, Keith W J Murray, 2013

### 4.4.4. Visual

Mariners are equipped to keep a good lookout and may often navigate with the aid of radar. Thus it is critical that the visual aspects in terms of lighting at night and general appearance during the day be considered from a navigational risk perspective.

#### 4.4.4.1. Navigational Lighting and Shapes

Each farm will need to have appropriate lighting, coloured buoys (if employed) and show correct navigation shapes in accordance with the standard rules and approval of the Harbour Master. This would be expected to be along the lines of having lights on each corner of a farm and possible additional lights along its length. Additionally, if a farm site has a barge or other floating structure separate to the farm, rules applicable to maritime lighting and navigation marks or shapes will apply.

To be effective and fit for purpose, all lights should be fitted with purpose built and manufactured mounts and designed for all reasonably anticipated sea conditions. The standard minimum range would be for one nautical mile. The navigation light flashing/ oscillating sequence should at least meet a defined International Association of Lighthouse Authorities (IALA) pattern. The flashing pattern of each farm should be similar (but not identical) to aid recognition. It is considered that some enhancements to these requirements would be both practical and beneficial and would not result in unreasonable costs. These enhancements may include a requirement for a minimum two nautical mile range, for farm lights to be synchronised (flash/occulting together as a group) and for any working lights to be positioned to prevent glare or excess reflections. The additional range for lights, suggested above would be particularly useful for bridge teams of large vessels as more time is required to execute an unplanned manoeuver.

A reasonable argument can be made that some aspects of *navigational* safety in the Waitata Reach and the Tory Channel area will be improved by the presence of the proposed farms. The area is navigationally complex due to its many bays and reaches, and few unmistakeable landmarks, in addition to being poorly lit. Having recognisable lighting at night on fixed structures in known positions would create clear points of reference for mariners. It is our opinion that as the locations of the farms will be charted and although not designed as aids to navigation will act to assist navigation for competent mariners. An example of this would be lights on the proposed Horseshoe Bay farm, which would assist incoming vessels, working in conjunction with the light on Maud Island, to indicate a safe route for navigation.

#### 4.4.4.2. Visual Impact

During daytime hours and in all sea conditions, having highly visible reference points while navigating complex areas can improve aspects of *navigational safety*. The existing farms structures are required to not impact the natural character of the coastal environments by visually fitting in with the local surroundings. This is reflected in the natural colour used for the barge in Figure 4 and also the selection of a lower profile design for the farm structure itself. This requirement creates conflict from a navigational safety perspective, as highly visible structures, which would stand out from their surroundings, are more recognisable and visible to mariners. Clearly at night time the requirement for navigation lights must be complied with.

The location of the mid channel farms highlight the issue of conflicting visibility requirements. As the farms are placed a distance from the coastline, the usual practice of painting or disguising the farm to match the backdrop is less applicable. An alternative approach might be to make a virtue of the visibility of any mid channel farms, thereby making them a feature that assists navigation.

#### *4.4.4.3. Navigational Benefits from Presences of Farms*

Given the isolated location of the entrance to the Pelorus Sound along with the very limited volume of traffic, having fixed stations manned with skilled mariners, equipped with medical equipment (defibrillator) and staff who are monitoring marine radio would be a significant positive addition to navigational safety in the area. These farms could provide assistance to vessels in trouble, be first responders to emergencies or be able to assist rescue operations with valuable local knowledge.

#### *4.4.4.4. Potential Cumulative Effect*

The increase in number of farms from the low number now to a somewhat higher number – that is from 3 to 7 in Tory Channel and 5 to 10 in the general Pelorus Sound area – is noted. However, from the perspective of a navigator of a vessel, these numbers are still low compared to the very many natural landmarks and hazards in the same areas. There could be the potential for confusion as to which farm is being sighted – most notably at night. However, provided those farms that are relatively close to each other have distinctly different light flashing / occulting patterns, given their know and charted location, as well as distinct features, their presence should be regarded as having an overall navigational benefit.

# 5. Risk Potential Associated with Farm Failures

The navigational risks discussed in the preceding sections assume that the farms and mooring systems operate as designed and the farm remains securely in place. If the mooring system or farm itself fails, a new navigational hazard could be created. If a farm became free floating after breaking away from its moorings it would become a hazard for nearby marine traffic and has the potential to damage existing structures/installations like mussel farms and jetties. As the structure would be under the influence of tidal and wind patterns, passing mariners would not have warning that the farm has moved from the position marked on the chart. The main barrier to such an event is the engineering quality of the mooring system and farm structure as well as the procedures to ensure it is operating and maintained as required.

## 5.1. Partial or Full Breakaway Consequences

A breakaway event would create significant hazards for vessels and farm staff, as this would represent a large, uncontrolled structure floating freely and potentially near navigational routes. Exactly how such a scenario would unfold cannot be known for sure. The farms considered in this risk assessment are in the Tory Channel and Pelorus Sounds. Each area has its own distinct traffic flows and so the consequences of a breakaway must be considered separately.

### *5.1.1. Tory Channel*

The Tory Channel is a major navigational route and so quickly issuing an alert to all watercraft skippers in the area and in particular ferry masters would be critical. A number of factors to consider for the consequences of a farm breaking away:

- It has been estimated that, given a breakaway at full ebb tide, with current in excess of two knots, the Te Pangu and Clay Point farms would arrive at Tory Channel entrance in 20-30min.[16] The proposed site at Tipi Bay in comparison would take approx. 10min to reach the same location. If a breakaway event occurred at the other proposed sites in the Tory Channel a greater amount of time would be available to get the farm under control and give warning to vessels.
- Large vessel transiting Tory Channel will either have a pilot or pilot exempt master on board. This assures detailed and current knowledge of the area.
- The farms are normally staffed, and if a GPS position monitoring system is in place to provide warning of an impending breakaway, ferries could be advised early of the breakaway and so avoid getting into a situation where they could not take safe avoiding action.
- The behaviour of a free floating farm can be predicted as a farm in production (i.e. containing fish) would have almost no wind effect and the movement will be almost entirely dictated by the tidal current flow. As this flow is known, the movement of the farm can be reasonably predicted. Farms structures that are not in production will

[16] Walker, D., 2011. *Navigation Report on New Zealand King Salmon's Proposal for New Salmon Farms in the Marlborough Sound.*

behave more like a vessel that is drifting in that wind effects will also influence drift movement. However, given the moorings will be under a lower load, a breakaway of a farm that is not in production must be considered an improbable event.

- In the case of Tory Channel if warning were given before a ferry has entered the channel, vessels would be able to divert to the alternative Northern Entrance to Queen Charlotte Sound. The view from ferry masters is that this decision is straightforward if given enough warning.[17]

### 5.1.2. Pelorus Sound

The traffic density in Pelorus Sound in the vicinity of the farms is low and tends to carry small numbers of people. The Sound is also wide with plenty of room to manoeuvre so the overall risk is considerably lower than for the Tory Channel. Nevertheless, a farm breakaway would increase the chance of a collision.

It would be impractical and indeed, unnecessary, to close the Pelorus Sound and redirect marine traffic. The key to reducing the risk would be to rapidly inform mariners that the farm had broken away, and its estimated position. Once forewarned skippers should be able to maintain an enhanced lookout, slowing down in the general area if necessary, and so avoid a collision. The likely attendant work boats would also act to limit risk to other skippers.

## 5.2. Farm Breakaway

The probability of a farm breakaway event is dependent on mooring design, maintenance of the mooring system and construction/installation.

### 5.2.1. Pen Design

As highlighted earlier there are three potential farm designs proposed for the nine farms; two rectangular designs and one circular design. Whilst the newer steel rectangular design is lower profile than its predecessor and the circular design, all the farms feature a low profile. A farm is less visible to smaller craft vessels due to the lower viewing angle and the fact that they are less likely to have radar. However, lighting and, in most cases, the presence of the service barge means the farms will still be reasonably visible.

The existing rectangular design has proven to be robust in the Marlborough Sounds. The newer steel, Wavemaster, design has a hinged/articulated assembly (on both the platforms and mooring mounts), and uses of foam filled plastic buoyancy devices and so is expected to be at least as robust. This design has been employed at 12,000 marine farm sites worldwide since 1985. The circular design is common in many farming locations around the world, including Tasmania, and is designed to withstand rougher conditions than their steel rectangular counterparts. Overall, all the designs are considered to represent little risk if the engineering steps detailed later are taken.

[17] email. (n.d.). MPI and Masters of the Aratere and Kaitaki.

### 5.2.2. Mooring Design

Due to a number of earlier mooring failures at the Tory Channel Te Pangu site, the last one being in March 2006, the proposed farms have moved towards the use of screw anchors. The advantage of screw anchors when compared to concrete blocks is that, once set, they cannot move. Because of this, mooring line tension should remain more even and can be accurately managed. This is critical, as the earlier simple concrete block anchor design has previously shifted in the strong currents. This resulted in the failure of a single mooring line, which subsequently caused a cascade failure of each successive mooring line following load transfer from one to another.

The typical failure mechanisms for screw anchors are by pull out, ether if the soil fails, or the anchor itself structurally fails. The screw anchor design is intended to ensure that the soil will fail before the anchor does. A test pull out is required at each site to determine the ground strength given the different soil parameters, which in turn gives the relationship between installation torque and pull-out capacity.

As some of the existing farms are in close proximity to existing mussel farms it is critical to ensure that the mooring locations do not negatively affect each other.

On the circular designed farms there is an option to use a mooring system that involves flexible rubber mooring ropes. This would be new to the region and will need careful consideration and analysis following international practice before a decision is made.

An unusual feature about the proposed mooring designs for the proposed sites at Tipi Bay and Motukina Point is that there are shortened mooring lines on the landward side of the pens. This is to accommodate the available space for mooring between the shoreline and pen. This is different to the design of the existing Te Pangu and Clay Point mooring systems and to the further nine that were proposed by NZ King Salmon at an earlier time.

To manage the limited uncertainty this situation creates, the mooring system design will need to be professionally engineered and peer reviewed. Given that, there is little reason to suppose that the arrangement cannot be reliably engineered.

### 5.2.3. Design for the Environment

The tidal current influences both the selection and design of farm components that can be installed. The Tory Channel is a high current area with up to 5 knots being experienced in places. The channel narrows and shallows towards the seaward end that causes currents to become gradually stronger with significant acceleration at the entrance to the channel itself. Each site in the Pelorus Sounds has different peak and average current conditions and experiences varying winds and waves due to the unique typography of the surrounding area. Along with the current, the tidal range needs to be factored into the designs of the farms. These effects are similar for all the farms along the channel and should be accounted for in the design process.

### 5.2.4. Debris from Farm

Items such as ropes, netting, floats or hoses may come loose from the farm. This may occur after periods of adverse weather conditions or due to operation/procedure errors. Once loose from the farm, vessels may become entangled or otherwise collide with the items causing potential damage to vessels.

## 5.3. Controls

To mitigate the potential of a breakaway event a range of complementary controls (layers of protection) should be employed in the engineering, monitoring and maintenance of the salmon farms to ensure failure does not occur.

### 5.3.1. Engineering Design

The engineering of the mooring system and pen design is critical to the prevention of breakaway situations and hence risk. It is therefore critical that quality engineering design is assured. Despite the generally low numbers of passengers on board most vessels, with the notable exception of the ferries operating in the Tory Channel, the effects of a worst case scenario could conceivably be severe. It is therefore critical that, to limit risk to an acceptable level, the probability of an initiating event is very low. The following established controls within the engineering profession reflect this risk and would be expected:

- Given that marine structures are subjected to forces and conditions that are difficult to quantify and so, together with the one-off locations, different mooring systems, range of soil characteristics and resulting conditions require experienced designers:
    - Employment of Chartered Professional engineers (CPEng) for all designs that are novel or generally outside of established standards.
    - Following best practice overseas engineering design and tried practices for salmon farms in similar conditions.
- Peer review by another independent engineer – also of CPEng or equivalent professional standing. This peer review should include confirmation of the research and calculations associated with the local environment (current and wave action), as well as the structural and load calculations.
- Full involvement of the design engineer in the installation and specification of the requirements of the maintenance plan for the mooring arrangements.
- Inclusion of the maintenance plan into the quality and safety assurance systems.

In addition to ensuring no breakaway event occurs, two additional “layers of control” possibly include the monitoring of the movement of a farm to give warning of a developing issue and establishing emergency procedures if an event occurs that would warn vessels. We note that this has been previously suggested during previous EPA processes.

### 5.3.2. Movement Monitoring

Movement monitoring is a critical consideration to ensure rapid alert to farms that have become free of their moorings. As the proposed farms are quite remote and may be unmanned at times, it will be critical to have early notification of a free floating farm. It is considered reasonable that a movement-monitoring regime should be employed.

Movement monitoring can be achieved with either AIS or GPS systems. Currently, salmon farms are not required to have an AIS system fitted. This has been suggested to assist in informing passing AIS equipped vessels. However, as this is not within the design intent of AIS, this solution may not be sound.

A GPS system is potentially better suited as it would enable monitoring to a much higher level of accuracy and would offer considerable value as a risk control. The accuracy (ability to monitor within metres) would allow the movement of the farm to be fully understood under

its normal operation, which will enable early identification of changes to be investigated and notified to nearby vessels, well before a hazardous condition develops. It is noted that given the low costs, many vessels, recreational as well as professional, have an ‘anchor alarm’ function on their GPS system that warns if the vessel moves outside a defined circle whilst at anchor. This system could be well utilised on the salmon farms.

### *5.3.3. Emergency Procedures*

To manage the risk in the event of a breakaway event, emergency procedures covering a number of different scenarios are required. It is assumed that suitable emergency procedures will be deployed.

# 6. Risk Evaluation of Proposed Farms

This section highlights and evaluates the risks discussed through this report in relation to each of the proposed farms. As indicated throughout this risk assessment, the following is an assessment of the risks presented in relative terms to the existing farms in the Tory Channel and Pelorus Sound.

## 6.1. Evaluated Factors

- **Collision:** The effect to all vessels from a collision with the proposed farms is consistent with that of the existing sites as the designs are broadly similar. The possible use of the new Wavemaster or circular design is not expected to be material to the overall navigational risk.
- **Position:**
    - **Tory Channel:** The positions of the Te Weka Bay and Tipi Bay farm sites are considered to be no more hazardous than the existing farm locations. Although, the farm location at Tio Point will be closer to the ferry path than the existing sites, it is within the headland-to-headland transit and so the risk will be only marginally influenced. The Motukina Point site sits on the outside of a turn in the Picton to Wellington ferry path. Interislander expressed some concern regarding this positioning. This related to the potential for distraction rather than creating a direct hazard. However, on close inspection and observation, it was found that although there is a perception that the farm will be close to the ferry track, in practice this would not be the case. Also, when compared to the existing natural hazards in Tory Channel, including narrow sections such as at Arrowsmith Point, any hazard created to the ferries will be marginal. Given the naturally hazardous maritime context it is essential that the vessels have reliable and accurate vessel positional and directional control – this acts to protect the farm and the ferries.
        - **Controls:** the following sensible controls would provide an additional layer of protection.
            - Implement procedures to require that ferries avoid passing each other on the turn at Te Uira-Karapa Point/Motukina Point location.
            - Ensure salmon farm operators limit vessel/workboat movements at pinch points when ferries are within the proximity.
            - Lighting. See over.
    - **Pelorus Sound:** The sites at Horseshoe Bay, Richmond Bay South, Blowhole South and Mid Channel Waitata are considered no more hazardous than the existing farm locations. The Blowhole North site is close to a natural transit route and outside the headland to headland line. However the sound is wide at this point and the traffic sparse so although vessels will need to steer further to seaward than now, the increase in risk is limited.
- **Activity:** Vessel activity in the local vicinity will increase slightly with the new farms due to the increased farm support traffic. This increase will however be moderate and, given that the craft will have professional crews who will be familiar with the

area and particularly the routes to, from and around the farms, would not be expected to impede other vessels.

- **Vessel Wake:** The effect of wake from vessels to the proposed farms is expected to be similar to that for the existing farms with a possible exception of Motukina Point due to its position on the outside of a turn. It is however understood that the anticipated level of wake can be accommodated by the proposed farm design. If this proves to be an issue the associated business risk lies with the farm developer.
- **Lighting:** The new farms can be expected to be an aid to small vessel navigation especially at night. This will tend to reduce some aspect of *navigational risk*. There is likelihood, dependent on the design of the lighting, that the spotting of smaller vessels by ferries is made more difficult by the lighting. However, simple engineered controls, in particular synchronisation of flashing or occulting of lights, should be employed to mitigate this effect.
- **Breakaway:** The engineering and design of the moorings and pen need to assure farm breakaway does not occur. The associated risk can be mitigated through design and peer review by a Chartered Professional engineer with the effects limited through monitoring of the farms movement to provide warning to vessels and appropriate emergency procedures for if an event occurs.
    - **Controls:** The following controls are considered essential to address the risks and have been identified:
        - Assure quality of engineering design
        - Assurance of the secure mooring of the farm (through design and engineering peer review processes)
        - Policies and procedures to ensure monitoring of the mooring condition and performance (real time and through inspection)
        - Systems and procedures to respond to mooring issues ahead of failures
        - Systems and procedures to respond to failures and ensure the farm is quickly brought under control in the event of a failure
        - Systems and procedures to warn vessels and in particular ferries of impending farm break away or other major events and to enable them to take any necessary action to ensure they are not put at risk.
        - Sound management of work activity associated with the farms (e.g. workboat crew training etc.) and ongoing assurance of this.

## 6.2. Comparison to Regulatory Requirements

The regulatory requirements stem from the Resource Management Act which, for navigation matters, refers to Maritime NZ. Maritime NZ publish guidance in Guidelines for Aquaculture Management Areas and Marine Farms. The key points are:

- **Access to bay, anchorages or mooring areas.** None of the proposed salmon farms are in or near recognised anchorages[18] or mooring bays. The farms are situated clear of the shore while allowing access to bays.
- **Clear of recognised navigational routes.** The Tory channel is a recognised navigational route. The proposed farms in the channel are considered inshore farms but do not meet the recommended separation distance of 500m. However, it is noted that the existing farm at Clay Point is closer to the navigational route than the proposed farms with the exception of Tio Point. The proposed farms are all within the headland-to-headland line or the bight of the nearby coast. It is considered that the headlands provide a greater hazard to shipping than do the farms. Pelorus Sound does not have a recognised navigational route. However, all the farms are clear of the natural navigational routes of local traffic.
- **Access for small craft traffic.** The proposed farm sites all offer at least 50m access between the shore and the farm. Two sites affect access to private wharfs, and both offer at least 150m access. Notably these wharfs only service a very limited number of properties and so cannot be considered in public use.
- **Safe navigation around headlands**. The proposed farms all lie more than 200m from headlands. In addition, a calculation of the reaction time allowed for a fast boat travelling close to the headland shows that there is sufficient reaction time.

[18] Murray, K. W. (2013). *New Zealand Cruising Guide - Central Area.*

# 7. Conclusions

While this risk assessment considered all proposed farms, it is evident that from a navigational safety point of view, the potential impact of farms in the Tory Channel is very different to that for the Pelorus Sound. The former is a single relatively narrow channel with a high proportion of large ferry traffic following a well-defined navigation route, whilst the latter is formed by more open water with almost no large craft and the smaller craft following natural navigation routes. Both areas have comparatively light traffic, the Pelorus Sound particularly so.

The limited or sparse use of the areas and the lack of representative accident data required a qualitative, rather than a quantitative, risk assessment to be undertaken - the level of risk being compared to the existing farms in the area. This risk assessment has also been informed by the legislative requirements surrounding the placement of salmon farms. Of note the requirements are not absolute with the resource Management Act referring to Maritime New Zealand for navigational matters. In turn, Maritime New Zealand has published guidelines for the placement of aquaculture management areas.

This assessment has considered the following risk scenarios:

- The causes and effects of a large vessel passing close by or impacting a salmon farm.
- The risk associated with the potential to influence the actions of a master or skipper.
- The interactions between a small vessel and a salmon farm.
- The causes and effects of a farm breaking free and creating hazard to other vessels and water users.

Given the rarity of large vessel visits to Pelorus Sound, the potential for a large vessel collision is realistically limited to the farms in the Tory Channel. Such an event would lead to injuries to people on the farm. Less likely is the disabling of the ferry's ability to manoeuvre, or the sinking of the farm. Whilst all the proposed farm sites are within the 500m recommended separation distance it is notable that three of the Tory Channel sites are within the headland to headland transit line, like the existing farms, and the third site, Tipi Bay, is within the bight of the coast in a similar way that the existing Ngamahau farm is. Given the significantly greater navigational hazard of the headlands, the farms create notably much lesser risk. All but the Tio Point site are further from the ferry paths than the existing farm at Clay Point. Given that the farm at Clay Point has previously been assessed as suitable and not impeding navigation, the sites further away can be reasonably taken likewise. A concern was raised about the Motukina Point site as the ferries do head directly towards the site prior to initiating the port turn on the outward path, while the channel is narrow at this point. However, the site lies some distance from the ferry track and within the headland-to-headland transit. Furthermore application of the two simple controls, avoiding the ferries crossing at this point and restricting the farm workboat movements when the ferries pass, would provide additional mitigation.

A small vessel collision with a farm could occur at any of the proposed sites. A collision could cause damage to the vessel and those onboard, the extent of which would depend on a range of factors including the speed of the vessel at impact. A record of AIS tracks

confirms that small craft do tend to stay close to the shore line, particularly in the Tory Channel to avoid the ferries, and that they navigate headland to headland. A further analysis of the Pelorus Sound area confirmed the natural transit routes. All the bay sites with the exception of the Blowhole North site are within the headland to headland transit line and so are clear of the natural transit routes. Blowhole North will require limited avoidance action by passing vessels. The mid channel site is also clear of the natural transit routes and, by its location, allows skippers plenty of room to safely pass the farm on either side. All of the sites are situated clear of headlands and give a reasonable reaction time for a speeding craft rounding an adjacent headland – even if close to shore and not complying with the rules regarding a safe speed.

No site prevents access to existing wharfs, navigation between the proposed farms and the shoreline or the use of bays for shelter. Whilst the farms would increase marine traffic, especially when constructing or relocating the farms, the effect can be considered minimal.

There is a conceivable possibility of a farm breaking free and thus creating a navigational hazard. However, experience has shown that this hazard can be adequately mitigated by good engineering design and other practical controls. The addition of a position monitoring system would reduce the risk to minimal by providing the farm crew good warning of undue movement of the farm.

Overall it has been found that the proposed farms would not unduly impede navigation and would have a very limited negative impact on navigational safety. The application of the controls identified in this report would further reduce any impact. It is noted that the farms should be correctly lit and will be crewed by well-equipped competent mariners with some knowledge of first aid and access to communications equipment. Given this and that the farms will be in known locations and their position charted, the presence of the farms could reasonably be considered to be an overall benefit to navigational safety.

# Appendix A. **Proposed Salmon Farm Locations**

**Figure 19 - Proposed Salmon Farm Locations - Tory Channel**

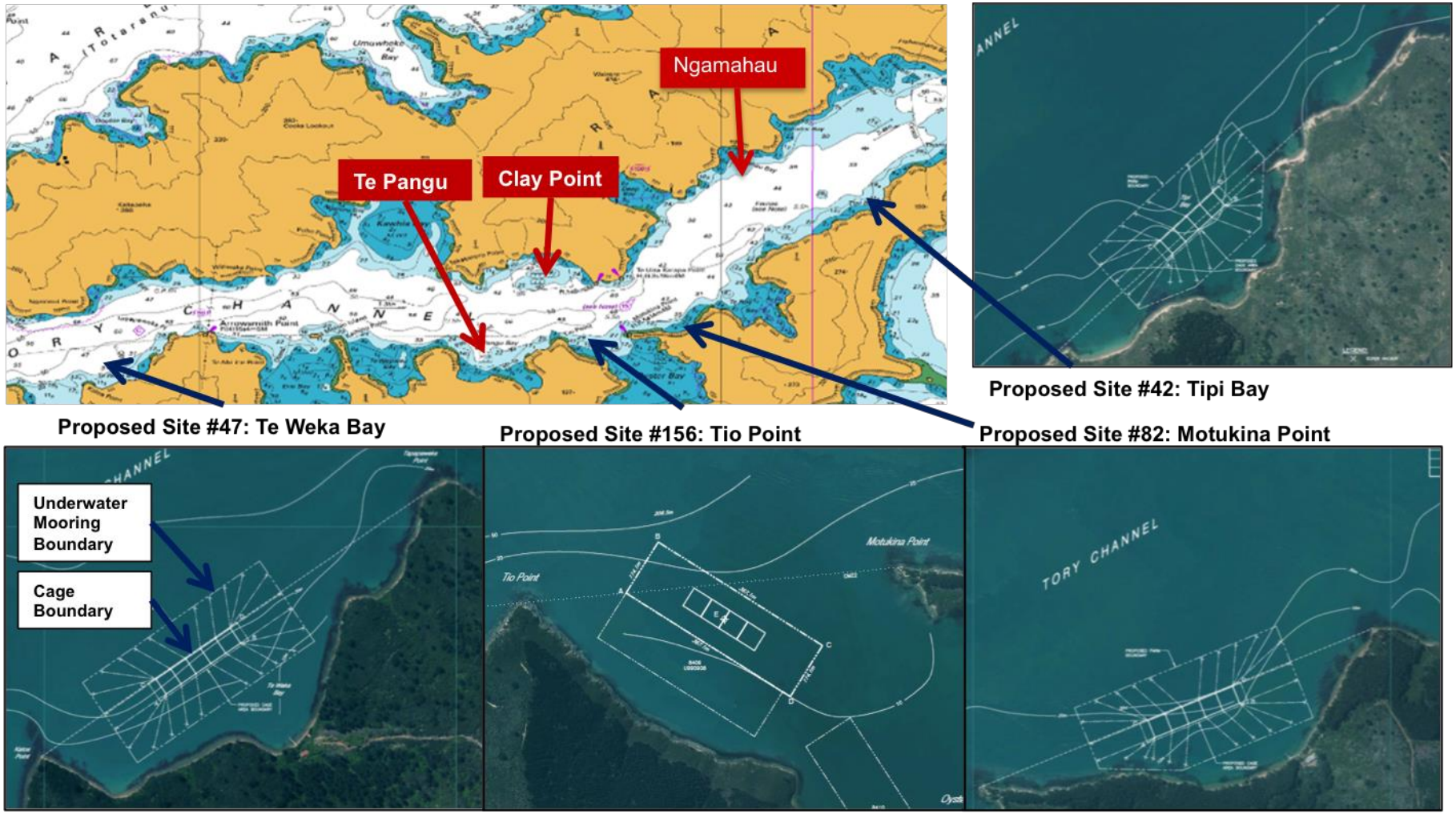


**Figure 20 - Proposed Salmon Farm Sites - Pelorus Sound Area 1**

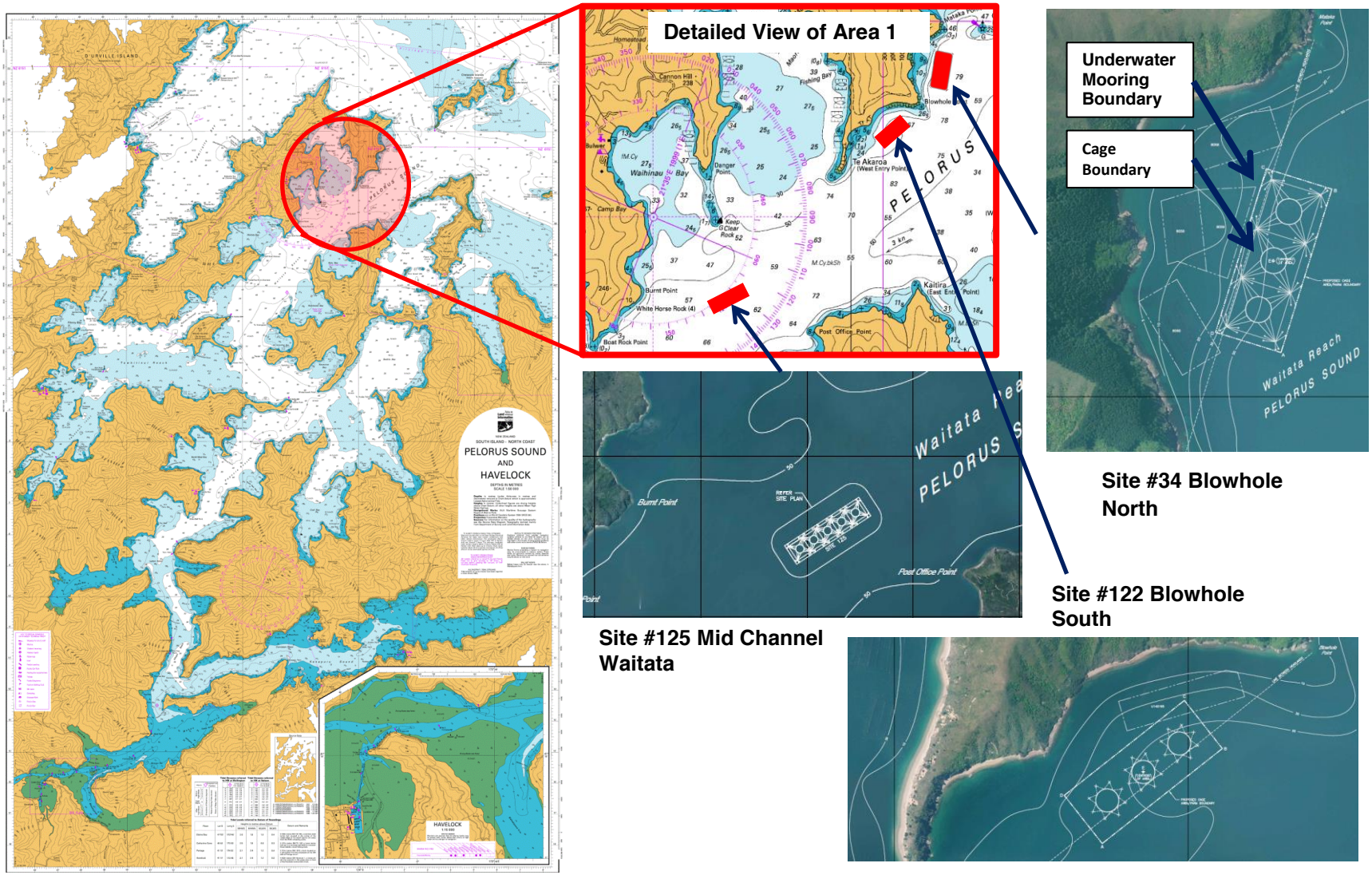
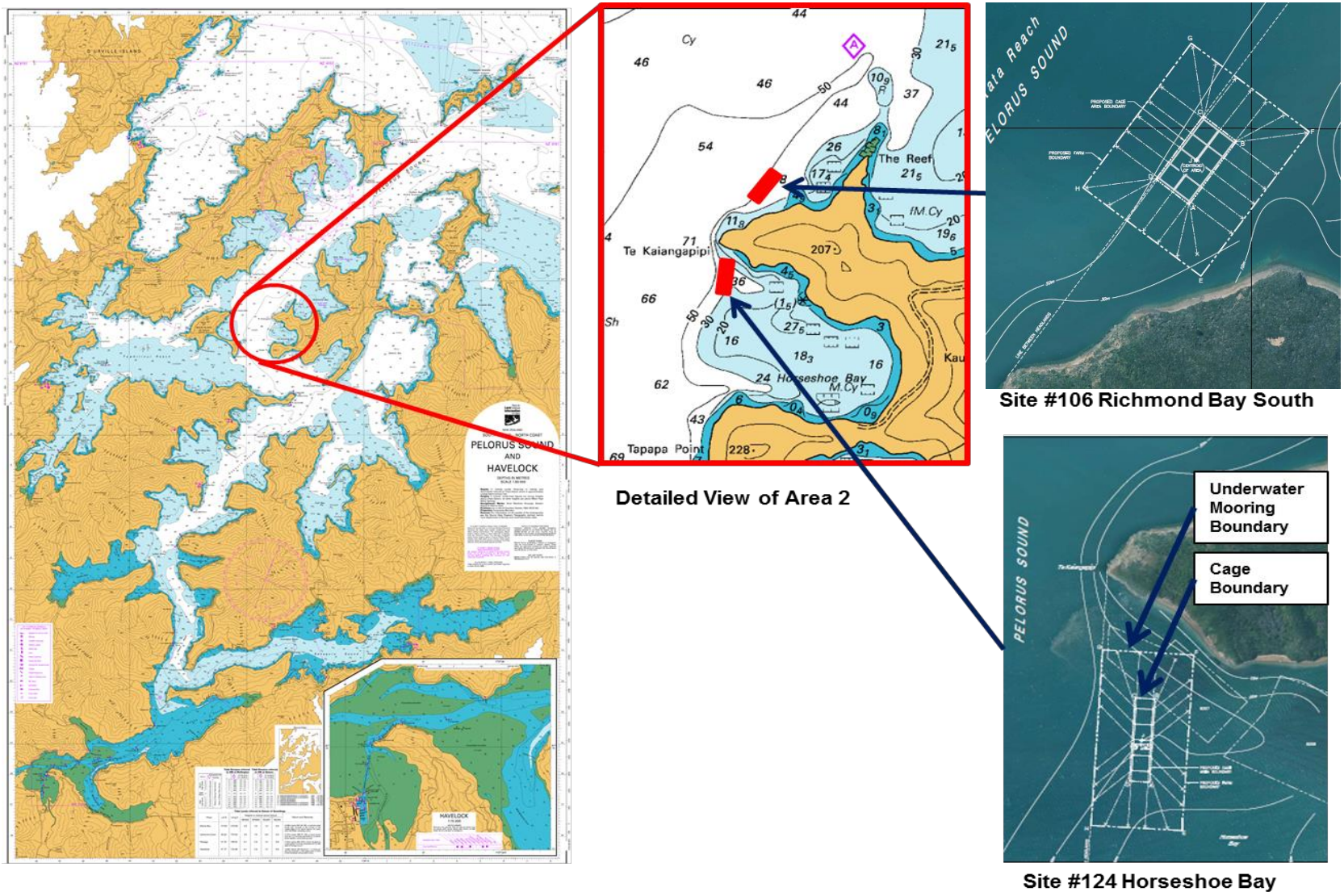
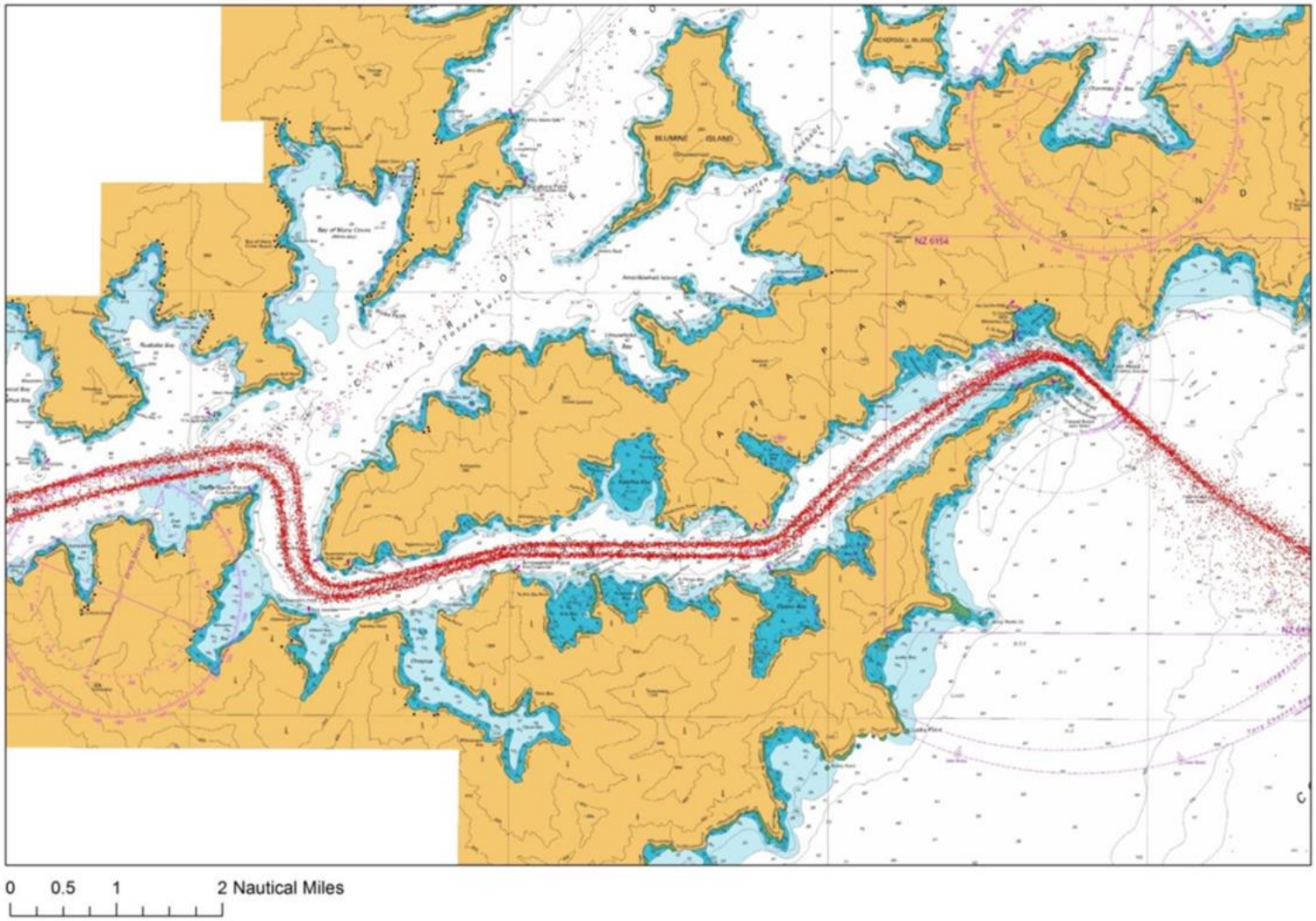


**Figure 21 - Proposed Salmon Farm Locations - Pelorus Sound Area 2**

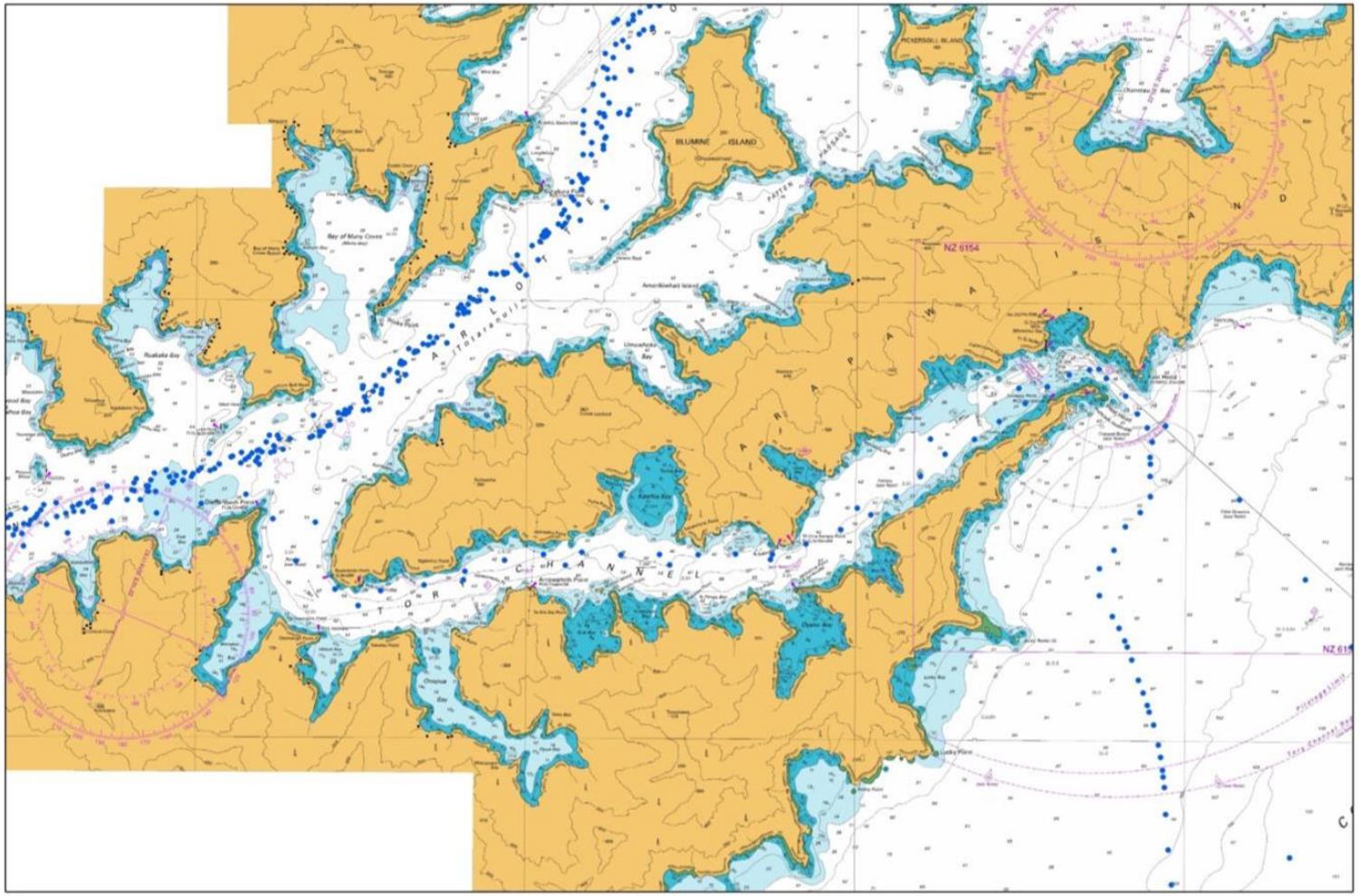


Appendix B. **AIS Tracks – Tory Channel**

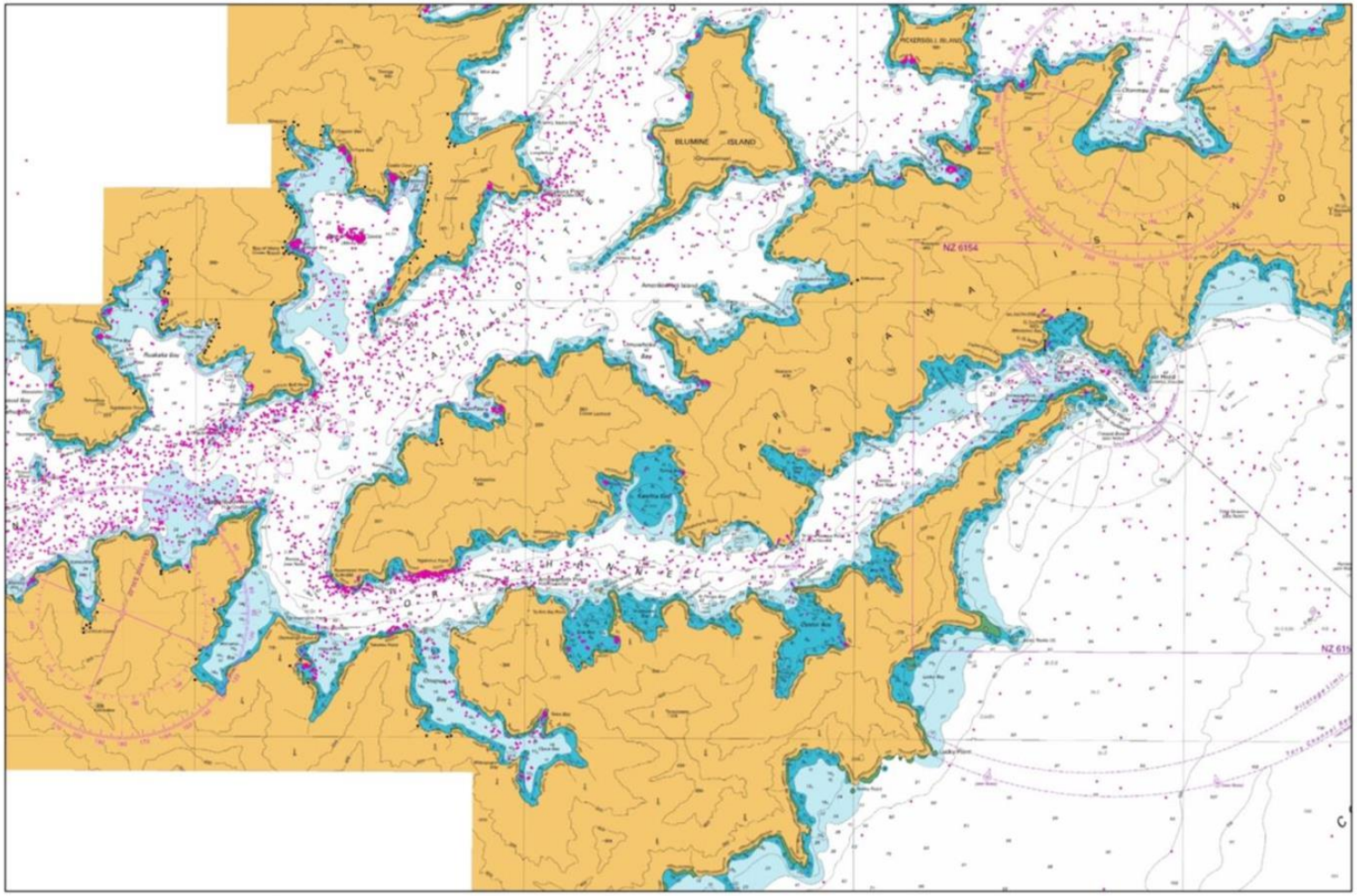
Tory Channel, January - March 2015 - Passenger Vessels



Tory Channel, January - March 2015 - Cargo Vessels



# Tory Channel, January - March 2015 - Pleasure Vessels



# Appendix C. **AIS Tracks – Pelorus Sound**

**Figure 22 - AIS Track Cargo Vessel**

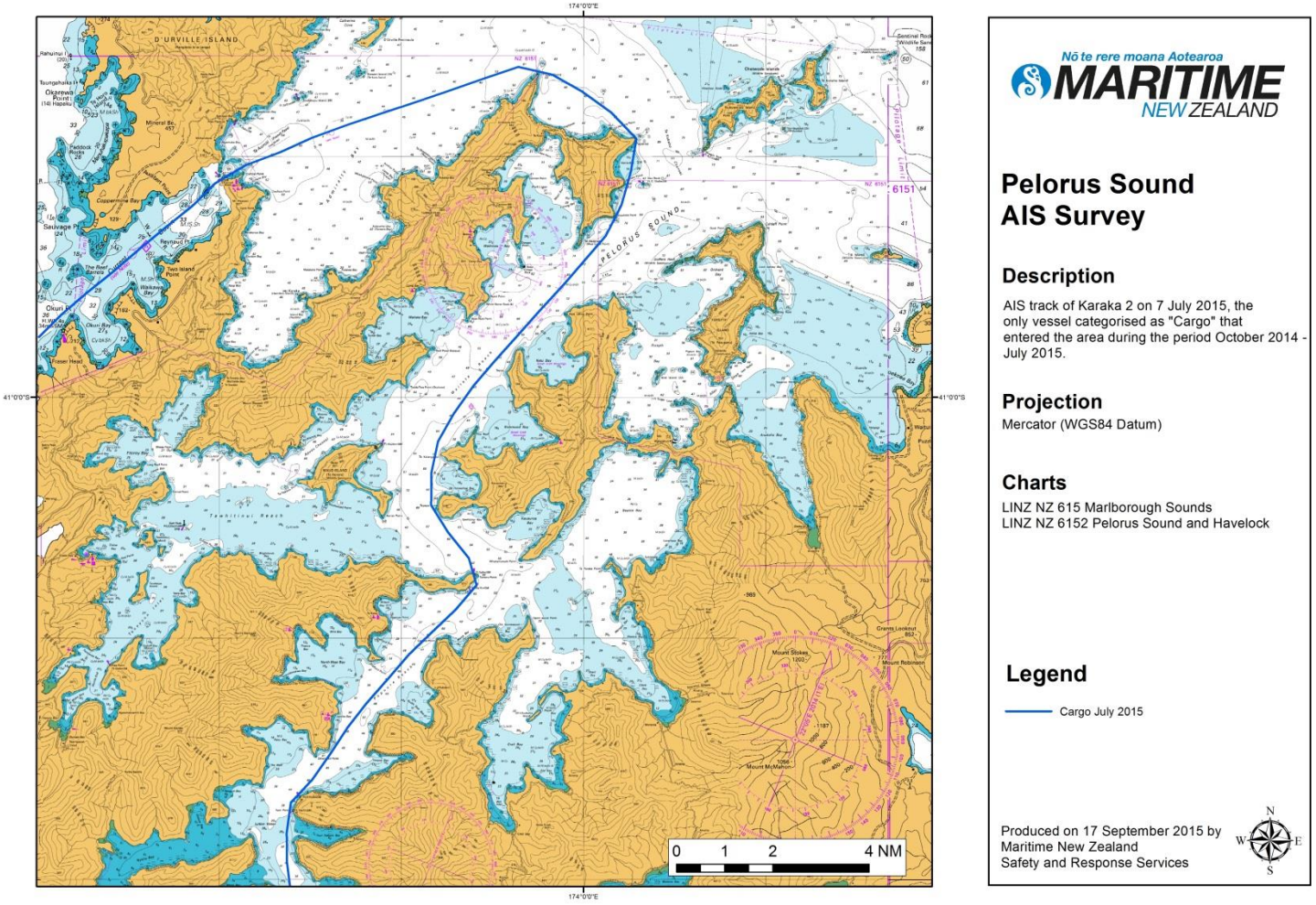
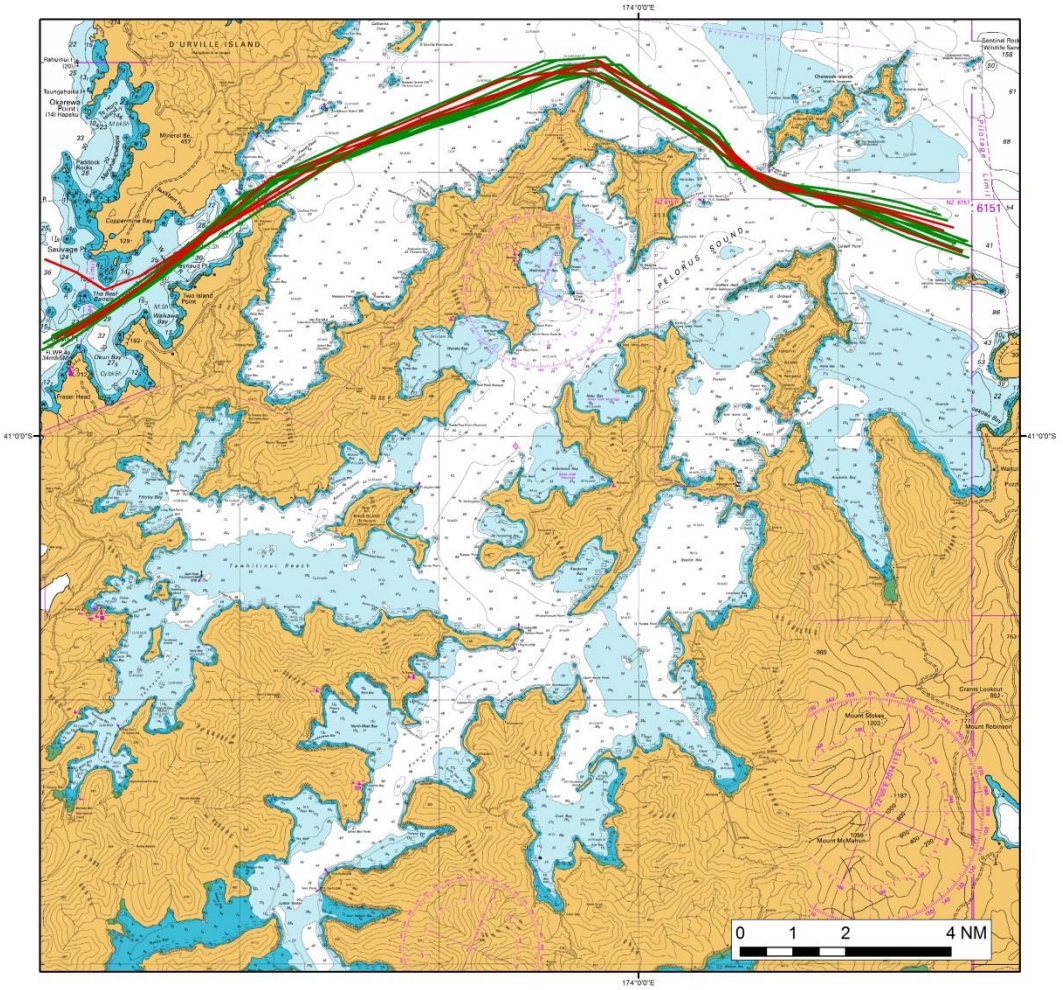


**Figure 23 - AIS Tracks - Fishing Vessels**




Nō te rere moana Aotearoa
MARITIME NEW ZEALAND

## Pelorus Sound AIS Survey

### Description

AIS tracks fishing vessels during January and April 2015. There were no tracks for October 2015 or July 2015.

### Projection

Mercator (WGS84 Datum)

### Charts

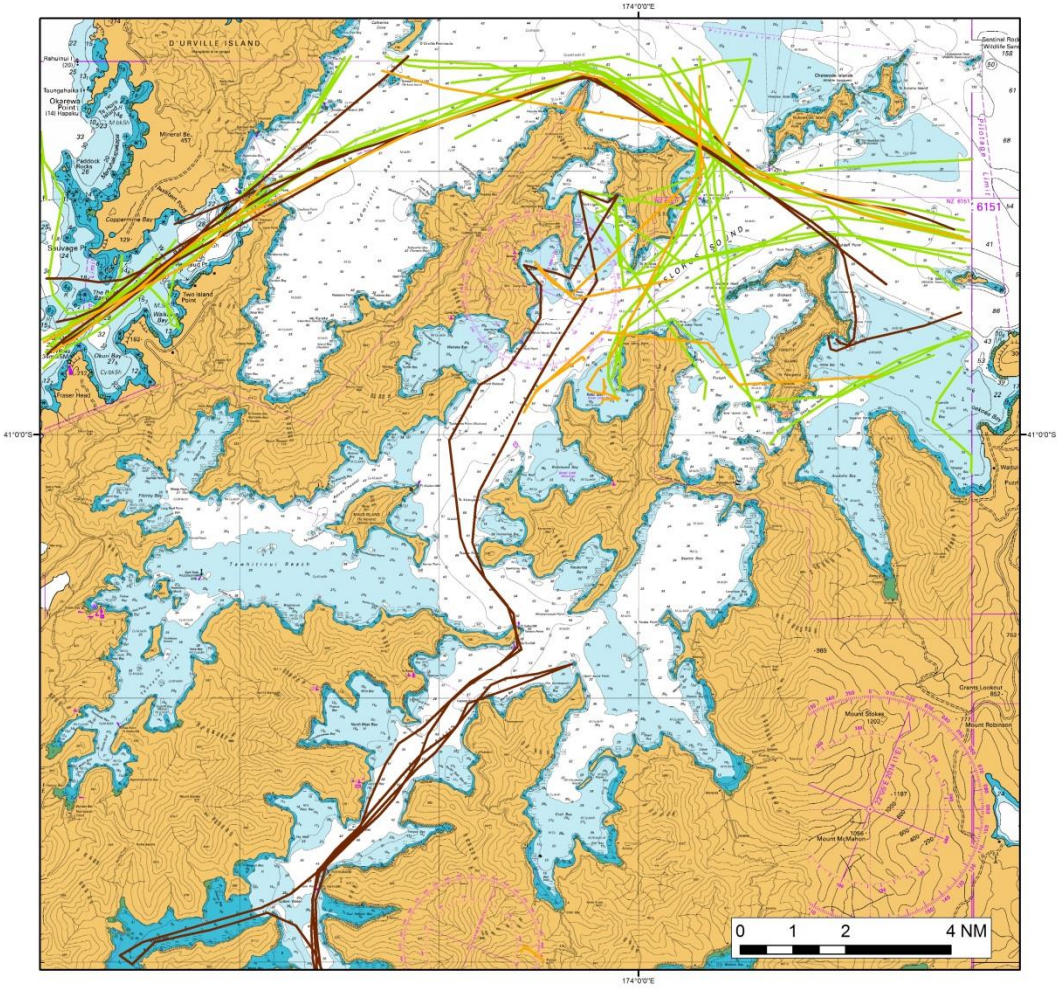
LINZ NZ 615 Marlborough Sounds
LINZ NZ 6152 Pelorus Sound and Havelock

### Legend

- Fishing April 2015
- Fishing January 2015

Produced on 17 September 2015 by
Maritime New Zealand
Safety and Response Services

**Figure 24 - AIS Tracks Pleasure Boats**

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## Pelorus Sound AIS Survey

### Description

AIS tracks of categories "Pleasure" and "Sailing" in the region during the period October 2014 - July 2015. There were no tracks for October.

### Projection

Mercator (WGS84 Datum)

### Charts

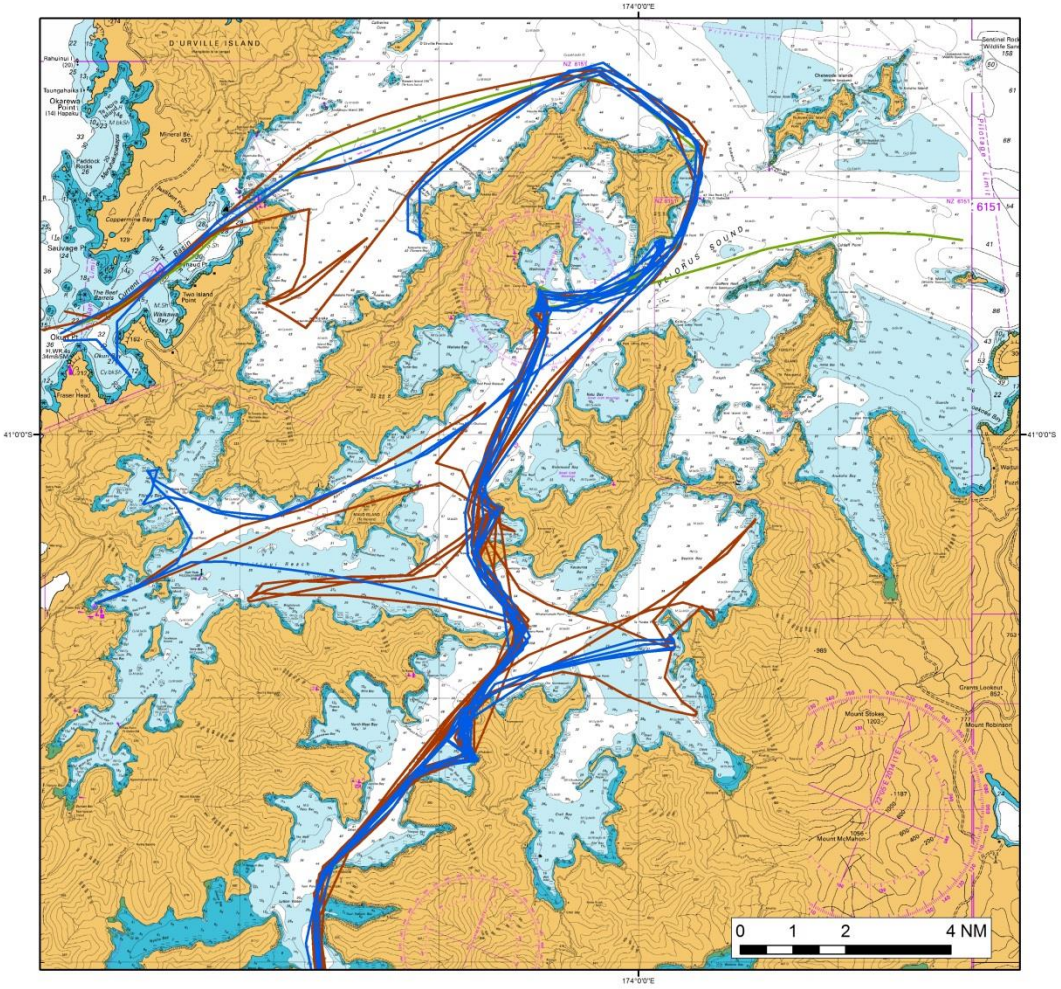
LINZ NZ 615 Marlborough Sounds
LINZ NZ 6152 Pelorus Sound and Havelock

### Legend

- Pleasure July 2015
- Pleasure April 2015
- Pleasure January 2015

Produced on 17 September 2015 by
Maritime New Zealand
Safety and Response Services

**Figure 25 - AIS Tracks Workboats**




Nō te rere moana Aotearoa
MARITIME NEW ZEALAND

## Pelorus Sound AIS Survey

### Description

AIS tracks of various vessel types including tugs, pilot, law enforcement, ship, etc that entered the area during the period January - July 2015. There were none for October 2014.

### Projection

Mercator (WGS84 Datum)

### Charts

LINZ NZ 615 Marlborough Sounds
LINZ NZ 6152 Pelorus Sound and Havelock

### Legend

- Workboats July 2015
- Workboats April 2015
- Workboats January 2015

Produced on 17 September 2015 by
Maritime New Zealand
Safety and Response Services